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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 5.

Staffordshire Iron and Steel Institute:—Combined meeting with the Birmingham Metallurgical Society and the Institute of Metals at Dudley. "Gas Producers." Paper by Ivor A. Bailey, B.Met.

West Riding of Yorkshire Branch.—Visit to David Brown & Sons, Limited, followed by a lecture on "Metallurgy in Gear Manufacture," by F. W. Rowe.

NOVEMBER 8.

Burnley Section.—Ordinary meeting at Burnley. "Foundry Practice." Paper by W. Holland.

NOVEMBER 9.

Institute of Metals (Swansea Local Section).—Ordinary meeting. "Pyrometers in Works Practice." Paper by Peter MacNair, Ph.D.

NOVEMBER 10.

Institute of Metals (London Local Section).—Ordinary meeting. "Some Metallurgical Problems of the Electrical Industry." Paper by C. C. Paterson, O.B.E.

NOVEMBER 14-19.

Public Works, Road and Transport Exhibition at the Agricultural Hall, London, N.

NOVEMBER 17-26.

Commercial Motor Exhibition at the Olympia, London, W.

NOVEMBER 23-24.

Institute of Fuel:—Annual meeting at the Institution of Electrical Engineers, Victoria Embankment, London, W.C.2. Annual dinner will be held on the evening of November 23, at the Wharncliffe Rooms, Great Central Hotel, Marylebone.

Bridging the Gap.

Modern science is tending to show many points of similarity between the behaviour of the ferrous and the non-ferrous metals, and experience in the one branch can now frequently be paralleled in the other. Metallurgists of an older generation, however, have been accustomed to thinking in water-tight compartments, in which the ferrous and non-ferrous fields were sharply differentiated. It is consequently much less puzzling to them than to modern students, for example, that the Iron and Steel Institute and the Institute of Metals should exist side by side. There is nothing in the title of the latter to exclude the ferrous metals, and officially, indeed, no such exclusion exists, but it is freely recognised, and has recently been commented upon with some force, that this exclusion is in fact a reality, and that while the one institution concerns itself solely with the ferrous, the other is very largely confined to the non-ferrous sphere. The somewhat unfortunate result has been to create an apparent rivalry where none need exist, and to foster a certain element of competition.

Moreover, since many people who are principally interested in the one branch find it essential to keep in touch with the other, either because they have a minor business or professional interest in the second, or because they realise how closely the two are related, there is the further unfortunate result that people thus situated are obliged to belong to two organisations, pay two subscriptions, attend two sets of meetings, etc., where it is by no means inconceivable, although possibly somewhat Utopian, that one organisation might cover the field.

It is not suggested that the time is yet ripe for any sort of union between the leading metallurgical institutions, but efforts might be made to foster joint action and meetings, both by encouraging any means of co-operation that already exist and by seeking new ones.

At the same time there is, as a matter of fact, one organisation which does offer a common platform for the discussion of many problems common to those engaged both in the ferrous and the non-ferrous fields. The Institute of British Foundrymen is not, of course, concerned with the discussion of abstruse metallurgical problems in which the behaviour of ferrous and non-ferrous metals may present similarities, for its activities must, after all, be primarily directed towards the foundry and the interests and requirements of those concerned with it. But there are a very large number of problems that do concern founding, and in which ferrous and non-ferrous interests can meet on common ground to their mutual advantage. Problems of moulding sands, or melting, of shrinkage and contraction, of casting design, and many others which will readily occur to every reader, are common to all founding processes, irrespective of the metal employed, and the iron-founder may learn from the steelfounder, the steelfounder from the non-ferrous founder, and so on.

Discussion, on a basis of subdivision by material, *i.e.*, ferrous or non-ferrous, has proved its value; we suggest that discussion, on a basis of subdivision by process, *i.e.*, founding, should prove no less valuable. The latter must inevitably concern itself to a greater extent with matters of practice, but it offers at least as firm a platform for co-operation and for the mutual exchange of ideas and experience. In actual fact, from the psychological point of view, it offers a sounder basis for interest, since every subject that is dealt with can be linked up with the process that is the chief concern.

La Semaine de la Fonderie.

Throughout France, last week was known as "La Semaine du Nickel"—"Nickel week." Its object, in the jargon of the advertising world, was to give people a "consciousness" on nickel, with the ultimate idea of increasing the sale of that commodity. In order to effect the publicity an exhibition was organised, whilst many of the best-known French metallurgists gave discourses on the advantages to be derived from adding nickel to both steel and cast iron. Now there is nothing very remarkable about this manifestation except its name. At the moment there are two exhibitions running in London, one devoted to the brewing industry and the other to motor cycles. They will achieve their usual success, but they are impersonal, and require something of that touch which has marked the success of the Semaine du Nickel. Now the foundry industry is to have an exhibition and conference in 1929 during June in London, and never will there be a better opportunity for publicity for the foundry industry as a whole than on that occasion. But it requires a sort of personality, and we suggest that its organisers might do well to copy the French (or is it really American?) idea and call it "Foundry Week." The daily Press has so many calls upon it that even the announcement of an "International Exhibition and Conference on Foundry Raw Materials, Supplies, Equipment, Products, and Research" would create but little enthusiasm, whilst the simple appellation, "Foundry Week," would instil a desire to know just what its organisers intended to do. It is difficult in this great city of London, with its thousand interests and activities, to centre its thoughts even for so short a period as a week on the subject of foundry work, but so much can be done by the broadcasting of a slogan or phrase that a serious attempt should be made to teach the general public that the basis of the whole of its comfort in life, and even civilisation itself, depends upon an industry about the very existence of which it knows so little.

Foundry Purchasing—XV.

By Eric N. Simons.

Fig. 1 shows a card that can be used for single orders. This gives details similar to those of the single contract card described in the previous article, but shows, instead of contract balance and deliveries, a space for the invoice value, and a wide column of "remarks," which is used for the full description of the goods ordered. Reverting to Fig. 2 in the previous article, it ought to be mentioned that where the contract is for an unspecified quantity, merely stating "our requirements for a period of....," the "quantity to deliver" column is used to show the *aggregate* quantity delivered to date.

Date.	Order No.	Quantity.	Price.		Inv. Value.	Req. No.	Remarks.

Description.

FIG. 1.—CARD USED FOR RECORDING SINGLE ORDERS.

The importance of having these various contracts and orders properly recorded and classified will be perceived when it is stated that no fewer than sixteen drawers are required by one not very large buying department to cover the raw material contracts alone, each drawer holding between sixty and a hundred cards. With this system, it is possible to turn up without delay any order for any class of article, by reference either to the order number or to the class of material. But in addition, to meet those instances that occur in even the most highly systematised office (when, for instance, some departmental manager, passing the buying office, calls in to ask "whether those bricks have come in from Smith and Company" without remembering the order number), an alphabetical list of suppliers should be kept in a loose-leaf book, and each order should be briefly recorded on sheets as shown in Fig. 2, filed under the supplier's name. As soon as delivery is made, the appropriate entry is crossed through, so that a glance enables the statistical clerk to say at

Name.	Town.	Material.	Price.	Delivered.	Inv. Value.

FIG. 2.—RECORD OF ORDERS FILED UNDER SUPPLIERS.

once whether Smith and Company have any bricks still to deliver.

In any efficient statistical recording system the buyer will, therefore, be able to turn up or refer to any order for any commodity in three separate ways. Thus, if he forgets the order number and the exact material, but remembers the supplier's name, he can turn it up under the latter by reference to the sheets as shown in Fig. 2. If he forgets the supplier, remembers the material, but forgets the order number, he can look it up on the cards classified under materials. If he remembers the order number, he can turn it up in the order book and examine the corresponding counterfoil, as will be shown in a later article.

The principal object of any past purchases record is to give an accurate summary of the aggregate amount bought, and the total value, with the prices paid, over any given period. This forms the foundation for all forecasts of potential future requirements, and enables the buyer to interview or negotiate with suppliers much more ably. He will know more exactly whether he can afford to buy a parcel of material offered at an exceptionally low price, but comprising a larger quantity than he usually orders at one time. He will know how and when to take deliveries. In short, he will be well informed on essential subjects. It need scarcely be said that the forms illustrated can be modified to suit individual requirements, additional information being included if desired. At the same time, there is always an advantage in keeping records as simple as possible.

Of the cards illustrated in this article and its predecessor, only Figs. 1 and 2 of this article provide for showing separately the value of an order, and these forms are not ideal from the economic point of view because they give no indication of dates of payment. A more complete record, giving this information, is shown in Fig. 3. Here the dates of payment are analysed over the following three months. Daily aggregates can be kept in soft pencil for each of these months, and in this way the total value of each month's purchases is obtained simply and easily. All these data are extracted from current order sheets.

Some firms, wishing to condense their buying records still further, have endeavoured to include in one card particulars of orders, invoices, stock inventories, and market data. It is exceedingly doubtful whether a compressed and tabloid system of this kind works in practice. At all events, the writer has yet to discover an example of a practical scheme. It cannot be laid down too often that, where possible, without too great labour, separate records are to be preferred. Too much information on one card or form tends to make the record excessively complicated and difficult to analyse, besides increasing the liability of the recording clerk to err. Since the information required for a unified or combined record card is precisely the same as is needed for separate cards, the work required for the latter exceeds by very little—if at all—that required for the combined card. Obviously, therefore, it is better to keep separate data separate, and to express their messages later in a combined or summarised form.

Current prices, market quotations, etc., will be obtained from divers sources. Travellers or suppliers' representatives are often in a position to reduce prices quoted by letter, and their reductions should invariably be noted down for future reference. Even when prices are quoted for goods not actually needed, it is as well to make a record of the offer. It is never waste of time to note down prices, even for commodities not likely, as far as can be ascertained, to be bought. Many times a buyer has to buy in a hurry some commodity that he has never had occasion to need before. Time or the small amount required may make it impossible or needless to send out inquiries to different firms, but that is no reason why he should pay more than the legitimate market price.

Date.	Order No.	Supplier.	Town.	Goods.	No.	Price.	Value and month of payment.					

FIG. 3.—RECORD OF ORDERS, SHOWING PAYMENT DETAILS.

It is, therefore, an advantage to him to be able to turn up in his records some offer or quotation that enables him to avoid paying more than he need. Of course, a certain measure of judgment must be employed in deciding what prices to keep permanently for reference; but it is better to have records too comprehensive than too limited.

It may be imagined that because the cards recording the previous purchases give certain price information, it is not necessary to keep separate details of current prices. But the previous-purchases records deal with materials and commodities actually purchased, not with materials that are to be bought. Fig. 4 shows the difference in design and scope between the records of past purchases and the records of quotations, prices, etc.

The former are primarily statistical in character, intended to give in handy form a summary of the work of the department over a given period, its financial commitments, the existing state of its order-books. The latter are mainly auxiliary, reference data to which the buyer can turn when contemplating or calculating the value of a potential purchase; when desirous of judging the economy of buying an offered parcel; or when uncertain whether to buy in stocks or to carry on from hand to mouth.

HAMMERS, CAST STEEL, FOR FETTLING DEPARTMENT USE.

Supplier.	Quotn. Date.	Quoted by.	No.	Price.	Per.	D/y.	Terms.	Disct.	Remarks.
John Smith	12.3.27.	Salesman	12	17/-	Doz.	Carr. pd.	Nett.	—	—

FIG. 4.—RECORD OF QUOTATIONS.

IMPORTANT EDITORIAL NOTICE.

Our next issue will contain a special 4 page supplement dealing with Tin, the most expensive metal used in large quantities in the non-ferrous foundry industry. Its history, occurence, mining, metallurgy uses, statistics, and future development will receive unique treatment.

Practical Moulding Sand Control.*

By N. D. Ridsdale, Consulting Metallurgist.

The scope of this Paper will be to deal mainly with "green" sands such as are used for iron and brass founding, and to indicate the nature and value of small scale tests both within and without the laboratory for assisting the practical moulder to use his sands to the best advantage. Prominence will be given to tests of a sufficiently simple kind which can be carried on by the moulder or foreman in the foundry, without necessarily requiring the services of a specially trained technical man.

The Properties of Green Sand.

In order to control moulding sands, it must first be realised what sort of tests will yield any information of real importance. Before dealing with this it is as well to review the essential nature of "green" moulding sand. It is a mixture of grains of sand stuck or bonded together with perhaps 10 or 20 per cent. of clay. The sand consists of fairly pure silica in the form of quartz. The clay is a more or less pure silicate of alumina. Curiously enough pure kaolin or china clay is not as good a bond as are many impure clays. The clay contains both free and combined water; the free water, termed "moisture," may be removed by drying at a temperature of boiling water (100 deg. C.), whereas the combined water is only removed progressively as the temperature rises from 100 to about 600 or 700 deg. C. (dull red). Once this water is completely driven off by heat the plasticity of the clay is destroyed and cannot for practical purposes be restored. The removal of *free* water ("moisture") will not affect the life of a clay. The sand grains vary in size from, say, 2 mm. diameter down to 1/10th mm. dia.; whereas the clay particles may be taken at less than 1/100th mm. dia. Most sands contain material between 1/10th mm. and 1/100th mm. in dia. which, in a virgin sand, may be regarded as fine rubbings from the sand grains. This material is known as "silt." In a floor sand, silt is derived partly from the "dead" burnt clay and unburnt coal dust. Silt is objectionable, because it has no binding properties like clay, but on the other hand it tends to diminish the stickiness of the clay and fill up the interstices of the moulding sand, also increase the amount of water to be added. Iron oxide is frequently associated with clay and up to 5 or 6 per cent. is regarded as advantageous, inasmuch as it has valuable binding properties which are not so readily destroyed by heat as they are in pure clay. These so-called "ferruginous" or red sands are consequently more durable. The more rounded in shape the sand grains are and the more regular in size, the more "open" is the sand likely to be.

The refractoriness of a moulding sand—that is to say, its resistance to fusion at high temperatures—is an important property, especially in the case of steel moulding sands, where the temperature of casting is considerably higher than that of cast iron.

The fusibility, again, is not dependent on the sand grains so much as on the quality of the bond, which, at best, melts at a lower temperature than the sand grains. Impurities such as lime, magnesia, soda and potash derived from the presence of minerals known as felspar, all tend to make the bond more fusible.

Desirable Tests to Perform.

It will be seen that the suitability of a moulding sand may often be best arrived at by studying separately the nature of the sand grains, the silt and the clay. The following tests give useful information:—(*a*) Fineness; involving sieving, elutriation or sedimentation tests to determine the proportion of sand grains, silt and clay; (*b*) mineral and "rational" analysis giving the amount of sand, felspars (minerals just referred to tending to increase the fusibility), and clay; (*c*) microscopic examination; (*d*) chemical analysis; (*e*) permeability (openness or venting qualities); (*f*) binding properties, or strength; (*g*) refractoriness; and (*h*) durability or "life."

Sampling.

Before dealing with these tests in detail it will not be out of place briefly to mention the question of sampling. Unless a reasonably representative sample of the bulk is obtained, the whole series of tests may be misleading and of little value. Heaps of sand may be quite uniform to the eye when in fact the distribution of the clayey matter and the size of the sand grains may vary considerably, and one shovelful from the surface of a heap is not sufficient to represent the bulk; a number of shovelfuls should be taken from different points both on the surface and deep down in the heap. A sample so obtained should be thoroughly mixed and a small sample drawn from it after quartering down several times. A long 2-in. tube, cut in half lengthwise to make a sort of magnified cheese tester, is a useful implement for sticking into sand heaps to draw samples. In sampling quarries, samples should be taken from the entire cross-section (vertically) of the surface of each layer at a number of different points along the face.

Fineness.

Sieving tests may be made with a series of standard sized sieves such as those recommended by the Institute of Mining and Metallurgy or the American Foundrymen's Association, but as these have to be done on the *dried* moulding sands the author does not regard them as of much value except for determining the larger grains—say, down to 0.5 mm.—because the dried particles unavoidably cake together to some extent and must give somewhat misleading results. By suspending moulding sands in water the particles lose their cohesion for one another, and may more readily be separated.

The process of elutriation is one which involves considerable time and patience and is not suited to works conditions. Particulars of this method may be found in the "Memoir of British Resources of Refractory Sands," Part I, by Prof. P. G. H. Boswell, O.B.E. (1918).

Sedimentation tests of a simpler and quicker kind have been brought to notice of foundrymen in a previous session by Mr. J. E. Fletcher and have been published in THE FOUNDRY TRADE JOURNAL, November 4, 1926, pp. 391-2.

Mineral and Rational Analysis.

Mineral analysis consists of separating the various minerals from the quartz grains; immersing the dried sand or silt washed free from clayey matter in heavy liquids of known density; for instance, in a solution of bromoform. Quartz and felspars, which are of a density below 2.76, will float while other heavier minerals will sink and may be separated and identified under the microscope. An outline of the method of mineral analysis of sands will be found in the "Memoir of Refractory Sands" already referred to.

With regard to "rational" analysis of moulding sands, a method recommended by Signor G. Guilo Sirovich (Rome) in the "Bulletin de l'Association Technique de Fonderie," September, 1927, in his Paper on the "Tests and Properties of Foundry Sands," is worth studying by chemists. By a simple treatment with acids and caustic soda sands may be resolved into quartz, clay, and felspars, and the amount of each determined. Erith sand is by this method shown as containing 76.38 quartz, 13.50 clay, and 10.11 per cent. felspar.

Microscopic Examination.

This is useful in connection with mineral analysis; it is also useful in revealing the shape and surface appearance of the sand grains and the extent to which the grains are coated with the claybond. It also furnishes other information, but space will not permit dealing with this method of examination in detail.

Chemical Analysis.

Personal opinion about complete chemical analysis is that the information it supplies is not often worth the time it takes to make it. A few short tests, for instance, for iron and carbonate of lime, are useful. Most of the information it gives can be gleaned by other and simpler means. If a chemical analysis is made it should be made on the sand grains, silt, and clay, separately, as this throws much more light on the nature of the components of the moulding sands. Take, for example, the following analysis of Compton red moulding sand, Table I, taken from the "Memoir on Refractory Sands," Part II, pp. 161-2, wherein

TABLE I.—*Bunter Moulding-sands.*

COMPTON SAND.

Chemical Analyses of Grade.

Analysis of sand as a whole. (dried).		MS. >0.25 and <0.5 mm.	FS. >0.1 and <0.25	cs. >0.05 and <0.1	fs. >0.01 and <0.05	c. <0.01 mm.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
86.90	SiO_2	94.37	89.10	85.31	69.05	58.17
6.43	Al_2O_3	2.82	5.32	6.95	14.15	19.58
0.98	Fe_2O_3	0.46	0.88	1.23	2.70	5.47
0.25	FeO			0.22	0.53	0.55
0.42	MgO	0.17	0.28	0.37	1.05	1.78
0.26	CaO	0.16	0.24	0.41	1.27	1.34
0.36	Na_2O	0.12	0.15	0.49	0.56	0.38
3.26	K_2O	1.57	3.13	3.31	5.45	5.37
0.35	TiO_2	0.06	0.21	0.43	0.97	0.73
1.00	Loss on ign.	0.48	0.71	1.43	4.28	6.34
100.18	Totals	100.21	100.02	100.15	100.01	99.71

MS. = Medium sand; cs. = coarse silt; c. = clay; FS. = Fine sand; fs. = fine silt.

the analysis of the bulk does not tell very much about the sand, but the analysis of the separated grades show, for instance, that the sand grains (MS. and FS.) evidently contain an appreciable proportion of felspars, since the alumina and alkalies are both fairly high. The clay is quite ferruginous, having about 6 per cent. iron oxides: moreover, it cannot be very refractory since it contains over 5½ per cent. of alkalies (soda and potash). The value of an ordinary complete analysis of moulding sand is greatly enhanced if the approximate mineral composition in terms of quartz, felspars, clay, etc., be calculated from it. An example given by Prof. Boswell is shown in Table II.

TABLE II.—*Showing Mineralogical Composition.*

	Per cent.
Silica	75.91
Alumina	9.44
Ferric oxide	3.26
Ferrous oxide	1.86
Magnesia	0.64
Lime	1.12
Soda	1.42
Potash	2.96
Titanic oxide	0.64
Loss on ignition	2.91
Total	100.16

Anal. W. J. Rees.

Mineral Composition calculated from the above :—

	Per cent.
Quartz	51.63
Lime felspar	5.57
Soda felspar	12.05
Potash felspar	17.53
	35.15
Clay substance	4.74
Hydrated iron oxide	6.13
Other constituents	2.51
Total	100.16

If the "rational" method of analysis already referred to is satisfactory it is a much quicker means of arriving at the mineral composition. It does not, however, show how much of the quartz exists as silt nor how much hydrated iron oxides are present. The rapid determination of moisture in moulding sands is a matter of great

* Paper read before the Middlesbrough Branch of the Institute of British Foundrymen, Mr. F. P. Wilson presiding.

significance, particularly in connection with preparing the sand heap.

It is important to remember that the sand should carry the least possible moisture which will give it the maximum strength; any excess beyond this may weaken the bond and is simply adding to the amount of steam which must be driven from the surface of the mould when the iron is cast. Further, it may cause blowholes and surface defects on the castings.

Amongst the rapid methods for the determination of moisture may be mentioned the moisture apparatus of the Dietert type described on pp. 82-83 of Proceedings of the I.B.F., 1925-6. It is illustrated in Fig. 1. The tube is closed at

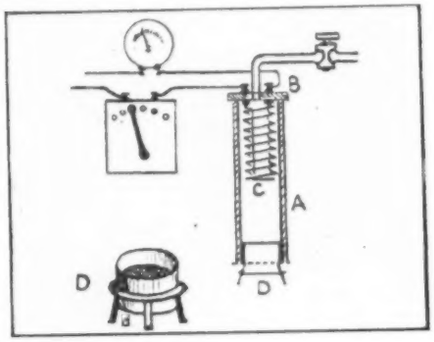

Fig. 1.—Dietert Moisture Tester.

the top by a plug containing an electrical heating wire surrounding a compressed-air pipe; the bottom of the tube contains a small sieve (*d*) which contains the sample to be tested. The compressed air is heated to 200 deg. C., at which temperature the sand is dried in a few minutes. The same investigator uses a method depending on the compactness of the sand being related to the moisture content. This method will be referred to later on in connection with the permeability tests.

Fig. 2 shows the McIlvaine moisture meter. It consists of a long tube which is filled with the sand to be tested by plunging it into the heap. At the top of the tube is a milli-voltmeter, and when a small electric current from a dry battery is passed through the column of sand, the reading on the meter indicates the amount of moisture present. The higher the moisture the lower is

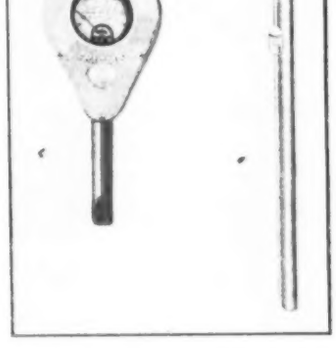

Fig. 2.—McIlvaine Moisture Meter.

the electrical resistance, and *vice versa*. The meter is standardised by noting the reading at a predetermined moisture content of the sand. The meter is, it is thought, used extensively in America, and in one or two foundries in this country. It should be invaluable to the foreman in checking the evenness of the distribution of moisture from day to day and at different points of the sand heap.

Permeability.

The American Foundrymen's Association, after several years' investigation, has evolved a test for permeability which is probably one of the best which is available to-day. It has the disadvantage of only measuring the permeability at atmospheric temperatures instead of under the conditions of casting, but it is worthy of attention in spite of its limitations. The permeability is measured by forcing air through a column of sand 2 in. long and 2 in. in dia. formed by ramming the sand in a standard manner by means of the rammer shown in Fig. 3. It consists of a steel rod supported by two guides; a steel disc is attached to the lower end of the rod and has a sliding fit in the sand container (*a*). A cast-iron rammer head, W, weighing 14 lbs., slides on the rod between two stops which allow only a 2-in. movement on the rammer head. A suitable quantity of sand must be taken (by trial) to yield a column of sand 2 in. long with a tolerance of 0.08 in. The rammer head is raised to the top stop and allowed to fall three times whilst the steel disc at the bottom end of the guide rests on the sand in the cylinder. After the sand has been rammed an indication of the moisture content may be obtained by means of the pointer, N, being swung into position. A given weight of sand will be compressed further into the cylinder as the moisture content is increased, and the pointer simply indicates how far the plunger has descended into the cylinder. The scale must be calibrated by compressing each type of sand with pre-determined amounts of moisture in increments of, say, 2 per cent. This device is the one already referred to under moisture determinations and has been put forward by Mr. Dietert. After reading the moisture the pointer is swung out of position, the guide is lifted and the cylinder is connected with the permeability apparatus shown in Fig. 4. It consists of a bottle, B, having a capacity of 3 or 4 litres and fitted with a large cork at the top. On the side are two marks, the lower one about 3 in. from the bottom and the higher at such a point that the volume of water between the two marks is exactly 2 litres. Tube C extends through the cork, within 1 in. of the bottle. On the outside it is connected with a tap. The tube should be 2 in. in dia. The next tube, D, starts just within the top of the bottle, the other end passing through the rubber stopper,

Fig. 3.—Rammer used for Testing Sands.

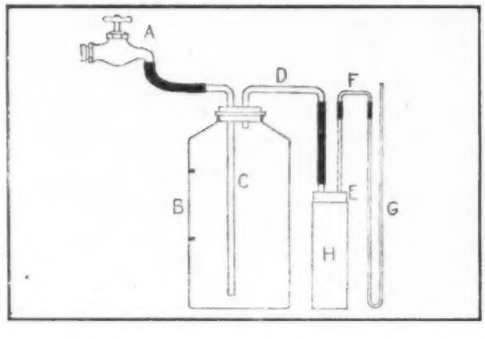

Fig. 4.—Permeability Apparatus.

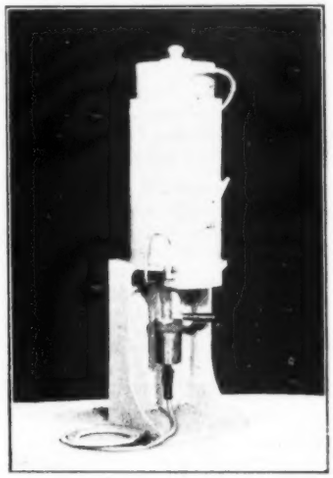

Fig. 5.—Permeability Apparatus for Works Use.

E, to which is attached the gunmetal cylinder, H, which contains the 2 per cent. column of sand to be tested. Through stopper E also passes another tube, F, which is connected with U, tube G, about 2 ft. long and behind which is a scale divided into inches. To use the apparatus, after connecting the sand cylinder, H, the tap is opened until water flows into the jar steadily at such a rate that the water in the U tube stands from 1 in. to a foot higher in one leg than in the other. Then, as the water rises in the jar the time is taken for the level to rise from the one mark on the bottle to the other, and the difference in level of the water in the two legs of the manometer is measured whilst the water in the bottle, B, is rising between the two marks. The permeability is calculated by multiplying the difference in water level in inches on the manometer by the time (in seconds) taken for the water to rise between the two marks of the jar and dividing this into 11,700. This gives the permeability of the sand in centimetre-gram-minute units. This means the number of cubic centimetres of air which would pass through 1 cub. cm. of sand in 1 min. if the pressure difference is 1 grm. per sq. cm. (see Proceedings, American Foundryman's Association, vol. XXXII, Part II, p. 120).

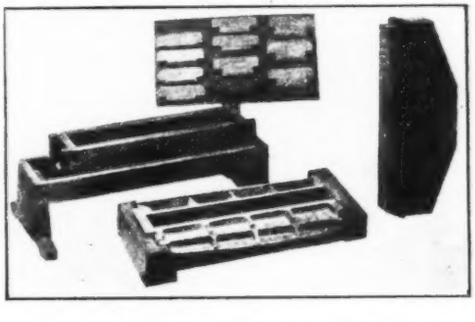

Fig. 6.—Mould for Preparing Test Piece.

This piece of apparatus, whilst giving satisfactory results, is somewhat fragile in the hands of those unaccustomed to glass apparatus. An improved portable apparatus based on exactly the same principle has been evolved by the American Foundrymen's Association. This is shown in Fig. 5. It contains no glass parts, and may be used to determine the permeability of sand moulds in position as well as sand from heaps, etc.

The permeability of dry sands could no doubt be determined in either of these pieces of apparatus by slightly modifying an ingenious method devised by Mr. O. Smalley, and published in the Proceedings of the I.B.F., 1922, p. 327.

Binding Properties or Strength.

Here again the American Foundrymen's Association has gone into the question very thoroughly and evolved a standard method of making valuable comparative tests. The standard test piece is prepared in a special moulding box, shown in

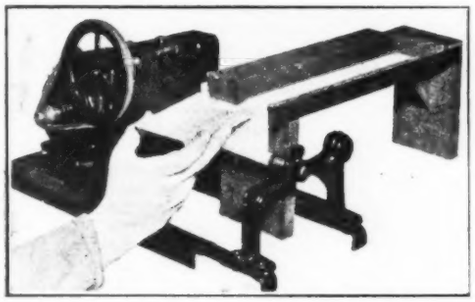

FIG. 7.—PULLING DEVICE FOR STRENGTH TESTS.

Fig. 6. The sand in the box is levelled off by using a series of strikes, as it is gradually filled with sand, and then a trussed rammer, shown on the right, is placed in position over the mould, which is subjected to a definite impact by means of a weight of 20 lbs. falling three times from a height of 16 ins. The test piece is then stripped and placed on the pulling device shown in Fig. 7. It will be seen that the test piece is laid on a piece of thin oiled paper at the edge of a flat table. The motor pulling device draws the paper forward at a definite speed and causes the end of the test piece to overhang. When the overhanging section of the bar breaks off by its own weight, the motor is stopped. The portion breaking off is caught in a convenient receptacle and weighed. It is clear that the stronger the sand the greater will be the portion projecting over the edge before it breaks off. This method takes an appreciable time to carry out, and involves the use of special and somewhat costly equipment. A much simpler and reasonably satisfactory method is to subject the sand test-piece used for the permeability determination to a gradually increasing compression until the test piece is shattered. Mr. Dietert has devised a compressing machine, illustrated in Fig. 8. The pressure is applied by means of oil, which is compressed by turning the handle on the right. As soon as the test piece shows signs of

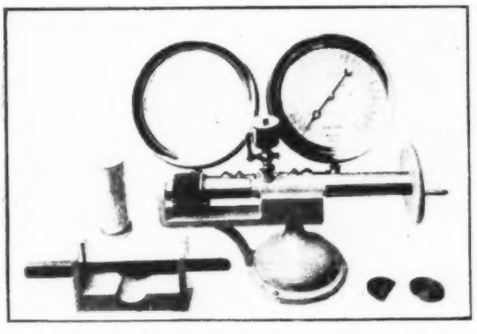

FIG. 8.—COMPRESSION TESTING MACHINE.

collapsing the pressure is stopped and its amount read off on the dial on the left; for the strength of *dried* sands the dial on the right is used. The saw shown in Fig. 8 is used for partly sawing through test pieces of oil-sand cores before subjecting them to compression. Fig. 9 shows a complete equipment for testing green, dry and core sands.

Experiments on Locally Used Sands.

The author has made a simple beam compressor which applies pressure to the test piece whilst in a vertical position by means of a sliding weight on the beam. Pressure can be gradually applied until the test piece collapses. A series of tests on sands used locally have been made at different moisture contents in order to determine the most suitable percentage of moisture to give both the maximum permeability and compressive strength.

TABLE III.—*Tests of Moulding Sands.*

Name of sand.	Per cent. moisture.	Compression strength (lbs. per 2" dia. Cyl.)	Permeability c.c.—grms. mins.
Heck	3.3	11.7	63
,, ..	4.3	15.4 (max.)	100
,, ..	6.0	12.8	121 (max.)
,, ..	7.3	11.4	99
,, ..	8.8 (as rec'd.)	10.1	91
,, ..	10.0	10.2	93
Mansfield ..	3.1	5.0	19
,, ..	4.0	12.8	27
,, ..	6.0	15.4 (max.)	28
,, ..	9.7 (as rec'd.)	10.6	31
,, ..	11.0	11.5	33 (max.)
Northallerton	6.4	12.6	46
,,	8.2	11.9	50
25 per cent. Northallert'n 75 per cent. Floor	8.0 (approx.)	8.9	61
Black Floor ..	3.1	Too dry to bind.	—
,, ,, ..	4.4	5.7	50
,, ,, ..	5.5 (as rec'd.)	5.7	59
,, ,, ..	6.8	6.0	64
,, ,, ..	7.3	6.4 (max.)	76 (max.)
,, ,, ..	9.0	5.4	76

Table III shows tests made on moulding sand from Heck, Mansfield and Northallerton; also on some black floor sand in a pipe foundry. It will be seen that Heck sand has a maximum strength at 4.3 per cent. moisture; increasing moisture causes the strength to diminish steadily. A noteworthy feature of this sand is the low moisture (viz., only 4.3 per cent.) required to give maximum strength. The permeability increases with the moisture until 6 per cent. of water is present, after which it again diminishes. The best moisture content for working this sand is evidently between

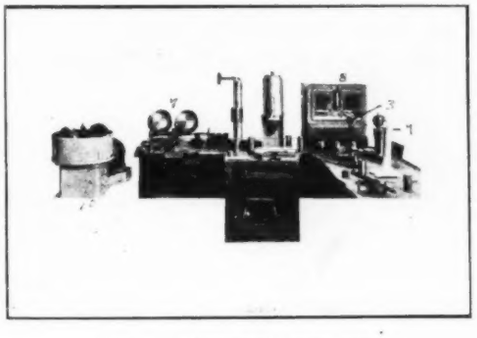

FIG. 9.—COMPLETE EQUIPMENT.

4 and 6 per cent., though the sand as received contains 8.8 per cent. moisture, which is more than is desirable. Mansfield sand is about as strong as Heck sand, but it will be seen that the permeability at its maximum strength is only about one quarter that of Heck sand.

Northallerton sand does not appear to be quite as strong as the other two, but it is appreciably more open than Mansfield, though it only has about half the permeability of Heck. When three parts of floor sand were mixed with one part of Northallerton, the strength was increased from about 6.4 to 8.9 lbs., but the permeability was somewhat diminished. When a virgin sand is used to rejuvenate floor sand, one should be selected which will increase the permeability as well as the strength. Probably the reason for the reduced permeability in this case was due to the fact that the black floor sand consists mainly of Heck sand, which is much more open than Northallerton.

TABLE IV.

Name of sand.	Per cent. moisture.	Compression strength (lbs. per 2" dia. Cyl.)	Permeability c.c.—grms. —mins.
Erith mild loam	1.6	13.0	24
,, ,,	3.6	13.0	29
,, ,,	5.2	13.0	30
,, ,,	7.8	17.0	32 (max.)
,, ,,	9.9	17.2	25
,, ,,	11.8	20.4 (max.)	26
Sinderby ..	2.6	Too dry to bind.	—
,, ..	4.2	3.8	93
,, ..	6.2	4.8	95
,, ..	9.0	4.0	109
Mixtures. Erith. Per cent.	Sinderby Per cent.		
0	100	9.0	4.0	109
25	75	8.9	13.8	60
50	50	8.9	14.9	38
75	25	8.9	16.0	36
100	0	8.8	17.1	29

Table IV shows tests made on Erith medium moulding sand, and Sinderby sand, which is a red open sand carrying very little bond. It is remarkable that Erith sand has a strength of 13 lbs., with only 1 per cent. moisture. By the way, it should be remembered that the moisture referred to in these tests is in every case that which is driven off up to about 100 deg. C., and does not include the combined water which is only driven off at higher temperatures. The maximum strength of the Erith sand was obtained when the moisture rose to 11.8 per cent., whereas the maximum permeability occurred with the moisture at 7.8 per cent.

The mixture of Erith and Sinderby sands gave some interesting information. It will be seen that when 25 per cent. Erith was added to 75 per cent. Sinderby the compressive strength rose from 4 to 13.8 lbs., whilst the permeability diminished from 109 to 60 cub. cm.-grms.-mins. Increasing the Erith up to 50 per cent. only slightly raised the strength of the sand, but considerably reduced the permeability, viz., from 60 to 38 cub. cm.-grms.-mins. A further increase of Erith up to 75 per cent. again slightly increased the strength, and only slightly further diminished the permeability. This table shows that if it is desired to open up Erith with Sinderby sand it is practically no use adding less than 50 per cent. of Sinderby, and to make any appreciable increase in permeability something like 75 per cent. Sinderby is needed. This may be a revelation to some who may have thought that an addition of, say, 25 per cent. Sinderby would appreciably improve the venting properties of Erith sand.

Refractoriness or Temperature of Fusibility.

A direct method of measuring the refractoriness of a sand is to mould it into small cones the same size as seger cones, and after having baked these dry, subject them to a gradually increasing temperature along with several seger cones of known melting points ranging from, say, 1,250 to 1,600 deg. C. When the sand cone softens and bends, the source of heat is cut off and a note made of the highest seger cone which has also softened in the same way. The heating may be conducted in a small vertical electric furnace lined with suitable resistance material. A furnace of this kind is used by research workers in the pottery districts. A simpler type of furnace may be constructed by boring a 2 in. diameter ×

2 in. deep hole in a magnesite brick. The brick should be held together by means of a steel casing and placed on a disc, which can slowly be revolved. Pointing down vertically on to the hole is an oxy-acetylene burner held with a clamp, which can be raised and lowered at will by turning a handle with a long screwed rod with a fairly coarse pitched thread. In this way the oxy-acetylene jet may be gradually lowered into the hole, at the bottom of which are the seger cones and the sand cones, mounted vertically on a disc of asbestos sheet held in position with alundum cement. By slowly revolving the furnace whilst the oxy-acetylene flame descends into it the temperature is sufficiently uniform to enable the refractoriness of the sand cone to be compared with that of the seger cones of known melting point.

The value of a test of this sort is that it may be conducted in a foundry where there is no laboratory, once the man in charge has been instructed and had a little experience with the test. The method of measuring refractoriness described by Mr. D. W. Trainer, Junr., in Vol. XXXIV, 1926, of the "Transactions of the A.F.A.," p. 327, may prove to be more useful, but it needs to be conducted in a properly equipped laboratory. The tests in his method were carried out in a muffle furnace capable of attaining a temperature of 1,500 deg. C. Mr. Trainer unfortunately, however, does not give particulars of the source of heat for this furnace.

Durability.

A method of comparing the durability or life of moulding sands was given by Mr. C. M. Nevin at the October, 1925, meeting of the A.F.A., but space will not permit dealing with this subject on this occasion.

The lists of tests recommended may appear formidable. However, it will be seen that the tests which are required for new deliveries of sands used regularly, and for floor and facing sand control are, fortunately for the foundryman, those which may be carried out quickly in the foundry, with a little practice, without expert control, viz., moisture, permeability and bonding strength. Durability and fusibility tests may also be made by him, but take longer. These, however, should only be occasionally needed.

Finally, it must be remembered that the properties of moulding sand may be entirely altered by the amount and quality of coal dust used in the facing sand mixture and the nature of the blacking used. The author here takes the opportunity of thanking the firms who have kindly provided him with samples of sand.

It seems apropos to conclude by quoting Prof. Boswell's words at the end of his book on "British and American Foundry Practice," pp. 93 and 94:—

"Although the subject of moulding sands appears to be a commonplace and relatively unimportant matter, there is a great issue at stake. The saving which can be effected in time, labour and money is literally enormous. . . . .

"The products of a foundry now play a large and important part in the life of the community. The foundryman is a highly skilled, conscientious and thorough worker. Good work and sound citizenship will be maintained in the future only by the better education of the workers.

"If, as seems to be the case at the present time, we are ahead of many other nations in both research and works practice in connection with foundry problems, it will only be by continued attention to such questions that our supremacy will be maintained."

The Paper was followed by a short demonstration of permeability and bond-strength tests in machines, the design of which was based on information supplied by the American Foundrymen's Association.

DISCUSSION.

Mr. Ritchie said it would be very interesting to know the effect on tests for permeability and compressive strength if a different number of rammings were given, say more or less than the usual three.

Mr. N. D. Ridsdale, in reply, said that in order to get comparative data, it was necessary to stabilise factors or one would get too many variables. There was no reason why the ramming should not be varied, but this would involve a series of tests for permeability and strength at different moistures with each particular degree of compression.

A Member remarked that one important point which was not very fully dealt with was the influence of coal dust on the sand. Some investigators had given papers on moulding sand, but in each case they had dismissed the influence of coal dust in a sentence or two. Coal dust considerably modified the properties of the sand, and it seemed desirable to have a Paper entirely devoted to the subject of sand mixed with coal dust.

Mr. N. D. Ridsdale agreed that it would be very instructive and useful to know the modifying properties of coal dust, but insisted that it was a question which needed special study individually, and the subject with which he was dealing had such a wide scope that many such interesting points had to be left out. Reference to the point was made by Mr. Fletcher in connection with his Paper given before the Branch a year ago.

Mr. C. H. Ridsdale said that it must be remembered that there was a great variety in coal, and that to deal thoroughly with the question one would need definite standards of coal and definite standards of sand; as there are 12 keys on the piano from which can be obtained a number of variations, so in this case one would need to make thousands of experiments of mixtures of sand and coals and it would mean an enormous investigation.

Necessary Properties of Coal Dust and Blacking.

Mr. N. D. Ridsdale said that in one foundry he noticed coal dust mixed with facing sand to an amount far beyond the point at which it could become effective; much of the coal dust was, therefore, serving no useful purpose, but was only clogging the porosity of the sand. It is important to remember that the function of coal dust is that it should burn readily and form a sort of gas pad to protect the surface of the mould. The coal used, therefore, should be high in volatile matter and low in ash, which latter should not be readily fusible. On the other hand, the blacking or other surface coating of the mould should resist burning, and, therefore, be low in volatile matter, and any ash or mineral matter it contains should be very refractory, which latter point is often overlooked.

Mr. Chester remarked that it was difficult to know what was Erith sand. Twenty-five years ago there was only one sand which came from the Thames and known as Erith. The only Erith sand sent to this district was supplied to the Stockton foundries.

Mr. N. D. Ridsdale said that the sample of sand supplied to him as Erith sand did not come from Stockton.

The New Bell at York Minster.

By H. Littlehales.

"Great Peter," the gigantic new bell at York Minster, was lately recast at Loughborough. After the casting had taken many days to cool, the great bell was disinterred from its native sand and taken back again to York, where some weeks ago it was restored to its place in one of the western towers of the cathedral.

"Great Peter" is not the largest bell in England, that distinction being held by "Great Paul" of St. Paul's, at London. A comparison of the two is not without interest.

The respective weights of these two great bells are roughly 17 and 11 tons. "Great George," the new bell of Bristol University, is 9½ tons in weight.

The well-known but always curious fact of the continuity of metal is shown in our knowledge that "Great Peter" probably contains all the metal, with some added, of the first big bell cast for York Minster many centuries ago. Something of the same indestructibility of metal is to be noticed in some of the lead of the windows of this same cathedral where we find the metal to have once formed part of the roof of Fountains Abbey church situated some miles from York. The accounts for the maintenance and restoration of York Minster for many centuries exist to-day, and would probably show the continuity of the metal cast and recast again and again of the various bells of the church. These accounts have been published under the title of "The Fabric Rolls of York Minster."

The new "Great Peter" is what is known in musical phraseology as a "bourdon" bell. At its widest part it is in circumference no less than 27 ft., and apart from its mighty headstock is upwards of 8 ft. in height. The enormous expanse covered by these great bells is not very readily apparent. In the garden of a South of England foundryman the two circumferences of "Great Paul" and "Great Peter" are marked horticulturally on a lawn, a design which might be adopted with some degree of interest by foundrymen and others. The two circles on the lawn exhibit little difference in point of size, but "Great Paul" is a taller bell than that of York.

"Great Peter" has been cast by the famous firm of John Taylor, a firm with a history going back to the middle of the 14th century when

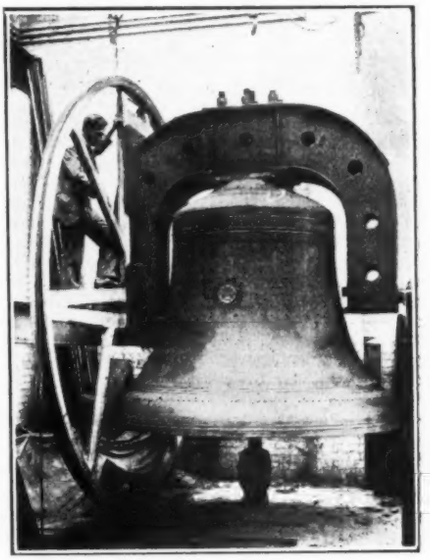

Fig. 1.—"Great Peter" of York.

Johannes de Stafford had his little foundry at Leicester and was distinguished as mayor of the town.

Our illustration has been furnished by the kind courtesy of the founders; it is a good picture, well displaying the graceful form of the bell, and in some measure the method of its attachment to the headstock; the delicacy and beauty of the decoration of the bell is clearly apparent.

From the historians' point of view, the old form of inscription, "I was made," etc., is perhaps preferable to the less personal inscriptions commonly seen to-day.

Every day at one o'clock the ringing of "Great Paul" can be heard by four million citizens, yet oddly enough the single stroke of the hour at one is more impressive.

The annual general meeting of the B.C.I.R.A. will be held at the Engineers' Club, London, on Wednesday, November 30.

Mr. T. Morris Prosser has retired from the joint managing directorship of Charles D. Phillips, Limited, engineers, founders, and merchants, of Newport, thus severing an association with the firm which has extended over 45 years.

The following firms have recently joined the B.C.I.R.A.:—British Celanese, Limited, Spondon, Derby (representative, Mr. Wilfred Yorke); David Colville & Sons, Limited, Glengarnock; N.E. Iron Refining Company, Limited, Stillington, co. Durham (Mr. Peter Kirk); and Watson, Gow & Company, Limited, Falkirk (representative, Mr. George Rae). Mr. C. P. Lee, of Singapore, has joined as an Associate member.

The Economic and Social Development of the American Iron and Steel Industry.*

By Theodore W. Robinson (Vice-President, Illinois Steel Company, Chicago).

The social and political character of any nation is largely dependent upon the extent of its economic welfare, and the prosperity of all classes of its people is contingent upon the prosperity of its basic industries. Because iron and steel directly or indirectly enter into every form of human activity and touch the life of every civilised human being, the conditions surrounding its manufacture mirror to a marked degree those of business in general. This is particularly true in the United States, which has enjoyed unusual industrial activity during the last few years. A description, therefore, of some of the more important changes that have affected the manufacture of iron and steel may well serve not only as a text of the progress of the industry itself, but as a means of illuminating some of the reasons for American prosperity as a whole. If this contribution helps toward a better understanding of an economic and social situation which during the last few years has been a source of widespread interest and investigation, its purpose will have been achieved.

Because of its subtlety current change needs time and distance for a proper perspective, and for the better comparison of the development of the United States in recent years a chronological base line has been established at the ushering in of the twentieth century. While this discussion is thus specifically concerned with the development of the last twenty-five years, the prelude of an earlier background may throw into stronger relief some of the conditions and forces that are in play to-day.

As late as 1860 manufacturing in the United States was chiefly confined to comparatively small units located in the communities that fringed the Atlantic seaboard. Transportation was slow and costly, and distribution was largely for local consumption. Industrial ownership lay in the individual, partnership, or small corporation, and there was close contact between men and management. Wages and output were low, luxuries few and far between, and standards of living were relatively simple.

Then came the epoch-making pneumatic process for making steel. It was the beginning of the industrial revolution which has made America the great workshop that it is to-day. The iron and steel industry was quick to grasp the possibilities of the new process, and steel plants began to spring up here and there throughout the country. By the Bessemer rail the Far West was opened, and the North and South were tied together. For thirty years unparalleled expansion followed the rapid development in railway construction, and men swarmed to American shores in response to the call for labour.

By 1880 manufacture was rapidly forging to the front. Individual ownership of the shop was giving way to the small corporation, and the small corporation to larger aggregations of capital. The former employer was becoming the employee, and there was less personal touch between owners and workmen.

With better and more extensive transport facilities industry became more highly centralised, and rural life was replaced more and more by urban life. The relative crowding of industrial centres helped to accentuate the change from former standards of living, and the transition was not always conducive to contentment and well-being. Factory conditions were crude and too often unsanitary, and the physical hazard of industry rapidly grew through the increased installation of power and machinery.

A class consciousness developed to an extent unknown before. The country was becoming richer, and with increased wealth Capital was prone to be more intolerant and Labour more independent, while both gave less heed than formerly to the power of public opinion; but in spite of these throes of a new industrial birth the country continued to expand.

Influence of Bessemer's Invention.

In reviewing this period it is clear that the underlying reason for the remarkable progress made in the twenty-five years following the close of the Civil War in 1865 was the introduction of the Bessemer process. No single industrial invention ever had such a vital and far-reaching effect on the commercial and social destiny of any nation as this new steel-making process had upon the United States. The first Bessemer ingot made in the New World was produced at an experimental plant at Wyandotte, Michigan, in 1864, but steel did not begin to be an important factor in the replacement of iron till ten or fifteen years later

When the Illinois Steel Company was organised in 1889, with an authorised capital of $25,000,000, by the combining of three important steel-producing companies in the Chicago district, it was properly heralded as an outstanding feat of corporate development. It represented at that time the most forward step in individual control of pig-iron and steel-producing plants, but even in this case the Company lacked complete operation, and had largely to depend upon outside parties for their ore and coal supply. As with other large steel producers in that period, the finished product chiefly consisted of rails, while the blooms and billets, which mainly made up the balance, were but the raw material for finishing mills belonging to other interests.

The following ten years from 1890 to 1900 were momentous in their import to the country, and were fraught with consequences that were fundamental in their influences upon the present life of the American nation. This period recorded the true beginning of big business, and iron and steel again played the most important rôle. The first seven years of the decade beginning with 1890 were lean and hungry. The necessity of rigid economy was emphasised by the severe industrial depression that existed. Liquidation became general and drastic, and by the time the pendulum swung toward brighter things the country was ripe for the saving and profit that lay in combination.

In 1898 the Federal Steel Company was formed with an authorised capital of $200,000,000. This brought under one management ore, coke, iron, steel, and transportation, to an extent only approximated by the Carnegie Steel Company. During this period most of the finishing mills throughout the country were brought together into large units, and they controlled in their separate entities the wire, tube, tinplate, hoop, and sheet-steel products of the country.

Such consolidations in iron and steel were largely typical of the change that was taking place throughout the manufacturing industry as a whole. It was a time of feverish activity. Promotion was rife, business ethics were low as compared with present standards, and as a result of public mistrust there was a marked change in Federal and State legislation from one of permission to one of restraint.

Dawn of the Twentieth Century.

The twentieth century opened auspiciously for the United States amidst long-deferred prosperity. The rapid progress made in the period just reviewed was founded upon new processes and new methods, distinctly technical in their character, which followed the introduction of the manufacture of steel.

The progress during the last twenty-five years, however, has been more essentially the result of social and economic change. Its history is a story of a nation adopting and assimilating the principles of big business: of the mobilisation of its capital and credit through the Federal Reserve system; of increasing its industrial output through co-operation, integration, and mechanical energy; of developing modern management as an entity separate from owner and worker, and of more equitably dividing among its people the fruits of industry through better opportunity and higher wages. In short, the story of the first quarter of the twentieth century is one of a nation commanding for its people the highest standards of living ever achieved by any nation by the scientific study and application of man and machine.

During the last twenty-five years the income of the United States has nearly doubled, while its population, though largely increased, has grown in a lesser ratio. The significance of these changes lies not so much in the increase in the nation's production of wealth as a whole, as in the surplus purchasing power that has sprung from the increased output of the individual worker. A large family may produce in the aggregate much more wealth than a small one, but if the large family accumulate no surplus, a small family with greater individual productivity and with the same proportionate cost of living may grow rich while the large one remains poor. A vital factor in the development of the twentieth century, and one which has been especially emphasised in the United States since 1914, is the multiplication of individual effort rather than the effort of multiplied individuals.

The United States during the past few years has been experiencing the unprecedented economic condition of continuously falling commodity prices, high wages, and continued prosperity. Any intelligent attempt to explain this anomaly must recognise certain elementary economic principles.

It is clear that wealth cannot be divided until it is produced, and obviously the more there is produced by each workman the more there is to be divided. Wages and dividends are primarily matters of wealth's distribution—not of its production. High wages mean high consumption. The larger the output of the individual workman, the greater is the tendency to lower costs and the greater the possibilities of return in wages and in dividends. Present easy money and low inventory are factors that influence but do not answer the question before us. High wages as a matter of distribution instead of production are an effect rather than a cause, and raw material, of which our forefathers had much more than we, is but of potential value until converted.

These are elements that enter into a complex problem, but do not explain it. Neither would increased production if accomplished merely by a proportional increase in the number of workers. The true answer to this economic paradox of combined high wages and lowering prices of goods, and the underlying primary cause of the late industrial progress of the United States, lies in the increased and unrivalled output of the individual American workman, and the large accumulation of wealth that has resulted from it.

The extent of this wealth is indicated by figures recently compiled by the National Industrial Conference Board from Washington statistics. These show that the value of the yearly product of the average workman in all the manufacturing industry of the United States rose from a *per capita* production value of $3,214 in 1904 to $4,682 in 1925, as measured by the common purchasing power of the 1914 dollar. This represents an increase of 45.7 per cent. in the manufacturing output of the average individual workman, which if applied to the total volume of manufactured product signifies that the increase of wealth in 1925, due solely to the increase in *per capita* production, amounted to $12,304,000,000 more than it would have been had the output of the average worker been no greater than it was in 1904; in other words, one-third of all the wealth that was produced that year from the nation's manufacturing industry was directly due to the increased productivity of the average individual workman.

How profound an influence such vast sums have on the whole economic structure of the country is perhaps better visualised when it is realised that twelve and three-tenths billions of dollars, on a basis of present individual production, is equivalent to the output of 2,628,000 men—a num-

* A Paper read before the Glasgow Meeting of the Iron and Steel Institute.

ber equal to nearly one-third of the entire working force of the United States engaged in the manufacturing industry. That the productive efforts of such a vast army of workers can be laid aside by machinery and management and rendered available for other additional work without an average increase in the country's non-employment is a striking commentary on the stimulating and absorbing effect of increased individual production.

The average output of the individual workman in the United States is to-day greater than ever before, and is much larger than that of any other nation. Canada comes next to the United States in individual productivity, and America finds its antithesis in the archaic industrialism of China.

An explanation of the increased efficiency attained by the manufacturing industry of the United States is found in the development of its iron and steel production. Of all basic industries the manufacture of iron and steel ranks first in fundamental importance and second in the amount of wages paid.

Production of Iron and Steel.

In 1901 the United States with its output, in round numbers, of 13,500,000 tons of ingots and castings, produced 44 per cent. of the world's steel. This by 1926 had expanded to more than 51 per cent. of the world's total, with its production of over 48,000,000 tons of steel. Whereas twenty-five years ago the steel ingots made in the United States consisted of more than 66 per cent. acid Bessemer, nearly 84 per cent. of the steel now produced is of basic open-hearth. This, in brief, tells the nation's accomplishment for the first quarter of the century, and records the large replacement of the Bessemer converter by the open-hearth furnace, a change superinduced by the changing character of the country's ore reserve.

The causes for this impressive growth, while clearly complex, are largely predicated upon economic and social change rather than upon any pronounced technical difference in method of manufacture. In principle, the blast-furnace, open-hearth, Bessemer converter, and rolling-mill are still the unchanged agents of reduction and conversion, and there has been but little progress made in the fundamental metallurgy of iron and steel during the twentieth century. Momentous advances in technique and the refinement in operation have resulted in an increase of output which can only be partially attributed to a multiplication of plants.

The production records of the past twenty-five years at the South Chicago Works of the Illinois Steel Company furnish a concrete illustration of the effect of such advances. These works represented in 1901, as they do now, the best modern practice. The average daily output of each of the South Chicago blast-furnaces increased from 318 tons in 1901 to 679 tons in 1926. During this period the acid Bessemer department increased its production from 70,000 tons to 100,000 tons per month, and the basic open-hearth furnaces increased from an average output per furnace of 586 tons per week to 1,379 tons per week. The South Chicago rail mill had an average capacity of 60,000 tons per month in 1901, while the Gary rail mill, by which it has been replaced in the rolling of rails, has a capacity of 100,000 tons per month. These figures reasonably illustrate the unit advance in physical production which has taken place in the iron and steel industry in the United States.

A still more important development in American practice is the increased *per capita* output of the average iron and steel workman. This is strikingly illustrated by the South Chicago records given in Table I.

This table shows that the average man in a modern iron and steel plant is producing from 1½ to eight times as much as he did twenty-five years ago. If translated into yearly volume, these figures indicate that at South Chicago the average workman has increased his ore-handling capacity since 1902 from 6,000 to 48,000 tons; his pig-iron output from 675 to 2,405 tons; his Bessemer ingot production from 1,761 to 3,730 tons; his open-hearth ingot production from 1,049 to 1,842 tons; and his rolling capacity from 603 to 1,240 tons of rails.

That this accomplishment is fairly typical of the changes that have taken place in like branches of the industry for the country as a whole is supported by data lately published by the United States Department of Labour, which shows an average increase in worker productivity upon a man-hour basis of 165 per cent. from 1899 to 1926 for crude iron and steel products.

Table I.—*Illinois Steel Company (South Works). Tons produced per Man-hour.*

	1902.	1926.	Increased percentage.
Ore unloading	2.087	16.835	706.7
Blast furnaces	0.185	0.698	277.3
Bessemer ingots	0.421	0.841	99.8
All open-hearth ingots ..	0.252	0.418	66.0
Rail Mill (South Works, 1902) }	0.189	0.416	120.1
,, ,, (Gary Works, 1926) }			

These results are impressive when it is recalled that they are based upon actual continuous records running over a quarter of a century in a plant which in 1901 represented the latest development in equipment, organisation and method, and one that during the intervening years has kept abreast of current change.

Such a transformation is essentially due to the enlargement of units, refinement of design, and the installation of labour-conserving appliances rather than to fundamental changes in process. Behind these, however, is the large addition of mechanical energy by which these improvements have been made possible, and at the back of all lies enormous investment and co-operation of men and management.

Power Installation.

The manufacturing productivity of any nation can be roughly measured by the amount of its mechanical energy, and the marked growth of power application in the United States has made possible its expansion and prosperity. From 1899 to 1925 the country's primary horse-power more than trebled, and as a result of this increase there is now 4½ horse-power at the service of every manufacturing wage-earner.

On the conventional assumption that one horse-power is equal to the unassisted physical effort of ten men, the average capacity of the individual worker in the United States is more than forty times what it would be if unaided by mechanical energy.

The manufacture of iron and steel has more than kept pace in power installation with the progress made in general industry. During the last twenty-five years its use of power has increased nearly fourfold, and to each of its workmen there is now given the energy of over sixteen horse-power.

The extent to which power usage has been amplified and the electrification of plant increased is strikingly exemplified by the Gary Works of the Illinois Steel Company. A short generation ago the reciprocating steam-engine was the principal prime mover in both primary and secondary units. At Gary the production and utilisation of power is dependent upon the blast-furnace gas-engine, steam-turbine, electric generator, and motor. Here 11,716 men were able in 1926 to turn out more than 2½ million tons of finished product, because behind each of them was the electrical energy of nearly 20 horse-power.

Wages and their Relation to Living Cost.

It is but natural to ask whether or not the increase in worker productivity, in which power usage is such an important factor, has been followed by an increase in "real wages." Wages and earnings in the Chicago district may be considered as typical of those existing elsewhere in the iron and steel industry of the country. In 1901 the daily wage was based on 15 cents per hour, and the average yearly earnings of all employees of the South Chicago Works for that year was $825. By 1926 the hourly rate had risen to 44 cents, and the average yearly earnings to $1,870, an increase of 127 per cent., or more than double the amount of earnings received before. With this increase in earnings went also a reduction of nearly 18 per cent. in the hours the men were required to work. Prior to 1922 the iron and steel industry had been operated almost universally on the basis of 12 hours for continuous operations and 10 hours for non-continuous operations. In that year the present 8- and 10-hour day working schedule was adopted, and several years earlier the seven-day week had been replaced by the six-day week.

In the first decade of the century there was no striking change in the basic cost of living or in the wage scales. By 1914, however, there had become pronounced that vicious circle of high commodity prices, high cost of living, and high wages which a few years before had begun to evidence itself. War conditions aggravated the situation, and commodities, living costs, and wages rapidly pursued one another upward in an ever-expanding sequence until the deflation of 1921. The social and economic consequences to the wage-earner and to industry are told by the following result of governmental investigation. Earnings in 23 representative industries increased 115 per cent. between 1914 and 1925. Living costs of workers' families rose 68 per cent., and the hours of labour decreased more than 6 per cent.

These figures indicate that wages in the manufacturing industry have more than kept pace with the increase in commodity prices. The surplus earning power thus represented well explains the present wide consumption of luxuries and the high standard of living that now exists.

Prices and Investment.

Granting that the economic change during the last 25 years has been distinctly beneficial to the wage-earner, what has been the contemporaneous effect upon the consuming public and investor?

If we take the price relation that existed between the composite steel price and the wholesale price of commodities in 1913 as a base, we find that whereas in 1901 the price of steel was relatively 52 per cent. higher than that of commodities, it was in 1926 3 per cent. lower. The composite price of steel is now practically 27 per cent. higher than in 1901, while the wholesale price of commodities has increased 99 per cent. Due to efficient management, the spending of many millions in power and machinery, and the co-operation of labour, the consumer, relatively speaking, is buying steel now cheaper than he did 25 years ago.

With the investor of to-day it is a somewhat different story, and this is especially true if there be borne in mind the difference in the amount of money represented by capitalisation upon which dividends are paid, and the much larger sum that is represented by the balance-sheet, and upon which earnings are dependable.

While there are from the Government no exact figures of the amount of money that is now invested in the iron and steel industry, the published balance-sheets of steel companies, representing over 85 per cent. of the country's ingot capacity, show a capitalisation of approximately 4½ billion dollars. According to these reports, earnings for the years 1925 and 1926 are respectively 5.61 and 6.70 per cent. on the capital invested. It thus appears that while the wage-earner, the consumer, and the public in general have been very distinctly benefited, capital has not fared so well.

Increase in Steel Capacity.

Due to the exigencies and stimulation of the war, the ingot capacity of the United States increased slightly over 15 million tons for the six years 1915 to 1920 inclusive, or at the rate of approximately 2½ million tons per year.

The end of the war left the country with excess plant development, and for six years subsequent to 1920 the total ingot capacity increased less than 3½ million tons, or at the approximate rate of half a million tons per year. The theoretical steel-ingot capacity of the nation is to-day, in round numbers, 58 million tons. While during the war no expense was spared to enlarge the country's steel capacity, investment during the last six years has been made with special reference to the reduction of costs, diversification of product, and the betterment of quality instead of increased production.

This explains why the installation of power and labour-saving machinery has been of late so

strongly emphasised, and why there has been such heavy scrapping of inefficient and obsolete machinery and plant. Irrespective of its physical condition or its length of service, it is not good business to continue to use machinery if a better design will pay a fair return on its investment by reducing costs. The American practice is drastic in this regard, and it is only by such a progressive policy that any concern or any nation can hope to keep abreast of the times and successfully maintain its position.

But given the vision and courage to adopt such a policy, whence comes the capital with which to finance such undertakings? It may be trite to recall that capital, practically speaking, is but earnings saved, but it is perhaps not so obvious that the amount of saving largely depends upon the surplus output of the individual. Because this surplus has been gradually expanding for many years through reproductive effort and reproductive investment, not only has wealth grown but its distribution is wider than ever before.

The nation's savings deposits of over 24½ billion dollars with its 46¾ million depositors is an index of the extent to which capital has been distributed, and the long lists of small stockholders in industrial corporations illustrate the rapidly growing character of its investment. The aggregate wealth of the United States no longer lies in the excessively rich, but in the small property owner whose name is legion and more and more does management represent and stand between him and concentrated ownership.

Management.

Just as the exigencies of expanding business fifty years ago resulted in the small corporation taking the place of individual ownership and control, so their resulting economies brought into existence the larger corporations of to-day. In the last two decades of the nineteenth century there was not always a proper appreciation of the difference in power and responsibility between large and small aggregations of capital. Management was then apt to measure responsibility and success by the profits it made rather than by the methods it employed. The rights of the public, the competitor and employee were oft-times neglected; monopoly was not always discountenanced; labour was sometimes exploited; prices were apt to fluctuate from exorbitant heights in good times to ruinously low figures in bad times; competition was frequently destructive, and business ethics too often failed to square with the golden rule.

Such principles and methods of doing business fell into disrepute years ago. Management learned that the difference between monopoly and unreasoning competition is the difference between ephemeral success to the few and industrial suicide by the many, that the exorbitant profits of a peak demand were offset by the losses of succeeding reaction, and that stability in price helps stability in operation.

To-day modern management stands not as the representative of capital alone, but as an entity representing the interests of the public, the stockholder, and the employee. For the development of this sense of plural trusteeship and the creation of the new spirit of co-operation that now animates all well-managed American concerns, the management of the United States Steel Corporation is in no small measure responsible.

The United States Steel Corporation commenced business on April 1, 1901, with a capital structure of nearly 1½ billion dollars. It represented a merger of ten large companies, each prominent in its own field. It was a consolidation of consolidations, most daring in its conception and destined to be monumental in its achievement. Its initial capacity in steel ingots and castings was 9½ million tons, which comprised 65 per cent. of the country's total output. To-day it represents but 45 per cent. of the nation's tonnage with its production of 23 million tons.

At the time of its organisation the failure of the enterprise was freely prophesied because of its colossal size. The public was suspicious of its monopolistic potentiality. Organised labour dreaded its power, and rivals feared possible unfair competition. During its existence it has twice been seriously attacked by organised labour, and for years it was in the courts because of the Government suit brought for its dissolution.

In spite of dire prophecy and unjust attack the Corporation after more than a quarter of a century of constructive effort, not only stands to-day absolved by the Government and the people of unfair practice, but is recognised throughout the industry as an exemplar of efficiency and high business standards.

From the beginning of the United States Steel Corporation the late Judge E. H. Gary guided its policies. To him was largely due that publicity in corporate affairs which principally found its birth in the innovation of regular and detailed statements of the Corporation's activities. To the public, the Corporation's policy has meant reasonable prices and knowledge of the Corporation's results; to its competitors, co-operation and a stabilising influence; to its employees, a more generous return than ever before paid by the industry; and to its stockholders, a fair return on their investment.

In management as in other departments of American industry the job seeks the man, and character and ability are the determining factors. Perhaps nowhere is the success of this dominant policy more strikingly illustrated than in the leaders of America's two largest corporations in the steel industry. The character and accomplishment of the late E. H. Gary and James A. Farrell of the United States Steel Corporation, and Charles M. Schwab and Eugene G. Grace of the Bethlehem Steel Company, chief executives and presidents respectively of their corporations, need no elaboration here. Their work and resource are distinctly an heritage of ability and hard work, and their history symbolises to a marked degree American opportunity and American accomplishment.

Labour.

Because of the large increase in the number of small investors the line of demarcation between so-called Labour and Capital is rapidly lessening. There is a better appreciation to-day that the nation's capital is principally the savings of labour's thrift and is largely owned by labour itself. With the dissemination of this truth has also gone a better realisation that in American industry the labour of the office and counting-room is in the same economic category as the labour of the mill or field, and that the officials of management are just as truly employees of the Corporation which hires them as the men working under their direction.

The composite American workman is of a high order of intelligence, peculiarly free from traditional bias and restraint, and welcomes as a rule mechanical assistance for the increasing of his output because of its greater attendant earnings. He is especially jealous of his right to freedom of action, is quick to resent unjust treatment, and does not hesitate to change the character or place of his employment if dissatisfied or if better opportunity presents. He resents political and organised domination, and prefers his own negotiations to bargaining by representatives.

That these statements reasonably reflect the general character of the largely predominating mass of skilled and unskilled labour in the United States to-day is demonstrated by the fact that attempted political dictation by organised labour even in their own ranks has been a failure, and that the United States is essentially an open-shop country. Of the 117,000,000 of its inhabitants about 44,000,000 are "gainfully" employed, and of these about 8,500,000 are found in the manufacturing industry. Organised labour has in its enrolment something less than 4,000,000 workers, and these are principally found in the mining, transport, building and textile industries.

Formerly when short-sighted management oft-times led to the oppression of the worker, and when co-operation between employer and employee was more stressed by its breach than by its observance, organisation of labour grew rapidly, because of its protective appeal to the individual. To-day, however, a better understanding of common aims and a clearer knowledge that even armed neutrality is unprofitable, has resulted in an appreciable lessening of interest on the part of the worker in labour organisations, as is indicated by a reduction in the membership of the American Federation of Labour from 4,078,740 in 1920 to 2,803,966 in 1926.

The iron and steel industry of the United States is operated on an open-shop basis. Employment is not concerned with nationality, politics, religion, or union affiliation; and plant representation, negotiation as to wages, and methods of work are distinctly between the management and the men, singly or collectively, and not through outside agents.

An exception to this general rule is found in a few small mills where the Amalgamated Association of Iron and Steel Workers is still recognised. That their influence is small is indicated by the fact that while the iron and steel industry employs about 400,000 men, the Amalgamated Association's enrolment has fallen from a membership of 14,035 in 1900 to 11,174 in 1926.

Some of the American labour unions have maintained their position through conservative leadership and the rejection of radicalism. More, however, have lost ground by attempting militantly to force domination on peaceful industry and by insisting on wages, hours, and rules that were unfair to the public because out of harmony with economic principles and existing conditions.

It is one thing for labour or for management to use its might to right a wrong. It is another thing to disrupt a community or a nation for selfish aggrandisement, and American public opinion has thus far refused to sanction special privilege to either labour, management, or capital.

As a result of this attitude both management and labour have found that fair dealing is remunerative as well as ethical; and that co-operation is more productive than oppression. That there has been of late years much better co-operation on the part of the vast majority of the labour body is by no means solely due to the higher wages that they have received. Management early in the century began more practically to recognise their obligations to the human side of the industry. It found that the minimisation of occupational hazard, sanitary surroundings, hospitals, better housing, and other welfare work which promoted the health and happiness of the worker and his family, was not only humane, but paid by the goodwill and the co-operative spirit that it inculcated. In the development and application of this new science of human engineering the iron and steel industry, inspired by the example of the United States Steel Corporation, has taken a most prominent part.

In 1906 the United States Steel Corporation inaugurated a campaign of safety, sanitation, and welfare which has ever since been vigorously pursued. Tonnage and costs became no longer the *sine qua non* of achievement, and the safety and welfare of the worker is a vital consideration in mill operations.

Accident prevention has naturally been most prominently stressed. The safeguarding of machinery starts with the drafting board in all construction, and is diligently pursued thereafter as experience permits. Education and organisation of men into safety committees plays an important part, and that expense is not allowed to interfere with the desired object is indicated by the expenditure by the United States Steel Corporation last year of 1¾ million dollars in safety work.

As a result of such intensified effort extraordinary reduction in the accident rate has been achieved. Among the quarter of a million men employed by the United States Steel Corporation in 1926 the rate of disabling accidents was 3.26 per cent. as compared with 20.57 per cent. in 1912, or a reduction of 84.15 per cent. of the former rate. That means that in the company 365,277 men have been saved from disabling injuries since 1912, as measured by the sum of the reduction in accidents each year.

In addition to the payment of liberal wages various corporations seek to improve the financial condition of their employees by affording them the privilege of stock subscription on advantageous terms. In the United States Steel Corporation, in illustration, there were 47,647 employees registered as stockholders as on December 31, 1925, who held 665,801 shares of the Corporation's preferred and common stock, with an aggregate value of over 100 million dollars. Like the Corporation's safety and other welfare activities, this method of encouraging a partnership relation is

absolutely divorced from any paternalistic method or condition, to which both men and management rightfully object.

Consumption and Markets.

At the beginning of the century the United States, with a population of 76,000,000 people, produced 9½ million tons of finished steel, while in 1926, with a population of 117,000,000, this output had risen to 35½ million tons. In other words, each inhabitant on an average used 739 lbs. of finished steel in 1926 as compared with 279 lbs. in 1900, or over 2½ times more now than formerly. This expansion is essentially due to increased domestic demand, and has been but little influenced by the small percentage of growth in the country's foreign trade. The following statistics show how small this change has been. The iron and steel imports and exports of the United States, in round numbers, were respectively 200,000 tons and 1,000,000 tons in 1900 as compared with imports of 1,000,000 tons and exports of 2,000,000 tons in 1926.

The increasing ramifications of steel's new uses are continually making for widening markets. With greater diversification of product has come an insistent demand for quality, so that to-day trade requirements are infinitely more severe than in former years. The comparatively rapid growth of alloy steels and the increasing call for electrical refining is a result of this demand, and such special steels are an important and growing factor in the economic progress of the country. The change in the character of the demand is illustrated by the item of rails. At the beginning of the century the production of rails absorbed 25 per cent. of the country's entire steel output. Last year, although the rail tonnage was half again as large as it was twenty-five years ago, it represented only 9 per cent. of the country's steel production.

In the new demand for steel the most important development is the expansion of the automotive industry, which last year took 15 per cent. of the nation's output.

In the development of this industry the accomplishment of Henry Ford is outstanding. To his genius, courage, and vision we must pay high tribute when analysing the effect of high production and the increased *per capita* production that has followed his methods. To his doors has come the world to study the specialisation of men and machines, and his practice and high wages have been made prosperity's text by various international expounders of economic and social conditions. But while industry owes much to Mr. Ford, his methods and his results may easily lead to false conclusions if superficially studied. Thanks to his foresight and inventive genius, he produced a car which in its sturdiness and its low price so far outclassed his competitors as to amount temporarily to a monopoly. With an almost insatiable public demand, his profits, though legitimately made, were so large as to put his enterprise outside the pale of ordinary competitive conditions.

It is as a monopoly, not as a competitive industry, that Mr. Ford's past achievement must be studied if proper deductions are to be drawn. The present intensive competition by powerful interests, in low-priced models, promises to emphasise this fact.

Between the manufacturers of steel in the United States there is free exchange of ideas and information in respect to equipment and practice, and former secrecy has given way to a courteous welcome to both foreign and domestic competitors. In the matter of sales, however, while information concerning prices may be legally exchanged, anything in the way of price agreement or restraint of trade is outside the law. Although industrial combination carries with it the possibility of service to the community by saving in operation and saving in distribution, it may also carry with it the possibility of unreasonable prices. That the public in the United States feared the possible monopolistic power of the industrial merger more than it appreciated its constructive force is evidenced by the Sherman anti-trust law and the subsequent anti-trust legislation that has been enacted. The difference between governmental encouragement of the cartel in Europe, and the discouragement of industrial combinations in the United States is, therefore, a difference in the public state of mind. That the United States laws against trade agreement and in favour of unrestricted competition are economically sound is subject to grave question.

Phosphor-Copper.

By "Celsian."

Of the different copper alloys commercially used, that of phosphorus combined with copper must be regarded as one of the most important, although the demand for it is comparatively small. Phosphor-copper is extensively used as a medium for the introduction of phosphorus into alloys, as, for instance, when 8 to 10 per cent. of the latter constituent is used for the production of phosphor bronze. As a deoxidiser for other purposes this alloy is also largely employed. The proportions most commonly in demand for phosphor-copper are 10 and 15 per cent.

As is well known, phosphorus is very volatile, and with alloys containing this non-metal in large proportions a high melting point is necessary, thereby incurring greater risk of loss than when a smaller percentage is introduced. By certain processes this loss is reduced to the minimum when 15 per cent. phosphorus is used in a phosphor-copper alloy. Claim is made that by the following method no loss of phosphorus is sustained and that a uniform phosphor-copper is produced with the introduction of 15 per cent. phosphorus. Experiments have proved that this may be accomplished by allowing the phosphorus vapour to travel over heated copper, 400 deg. C. being considered the most satisfactory temperature for the latter. The boiling point of yellow phosphorus is about 290 deg. C. Directly this vapour travels over heated copper, combination occurs with incandescence and incipient fusion. By this process a glowing wire of ¼ in. in diameter may be entirely phosphorised.

Preparation of the Alloy.

To demonstrate the importance of the process an apparatus was built of iron, as this metal is not attacked by phosphorus at 400 deg. C., this being the maximum temperature required during the process. This apparatus includes a container for the copper and a retort for heating and distilling the phosphorus. Means are also supplied for heating these constituents separately. The *modus operandi* is as follows:—Copper scrap, which may be wire, turnings or millings, provided they are clean, is put into the container, the phosphorus being placed in the retort and relations established between these vessels by fittings supplied for the purpose. In order to eliminate any loss of phosphorus the joints are fitted closely, suitable gaskets being used to ensure this. Any increase of pressure within the apparatus is prevented by drilling a hole into the covering provided in the end of the container. Prior to applying heat to the phosphorus, the copper is heated to 400 deg. C. By the use of this small contrivance distillation of the phosphorus may be accomplished at the rate of 30 lbs. per hour.

When the correct temperature is maintained throughout the process, no intermediate products are formed, phosphorisation to 15 per cent. phosphor-copper occurring directly in one stage. In the case of a greater proportion of copper being charged in the container than is actually required, to combine with the phosphorus employed, the copper furthest away from the phosphorus retort remains unaffected. The latter may easily be separated from the copper nearest the retort which becomes entirely phosphorised. A similar result may be detected when phosphorus vapour is allowed to pass over a glass tube several feet long containing heated copper turnings. Experiments have shown that the process of phosphorisation may in this manner be followed, and that immediately on cessation of the phosphorus vapour passing over the copper, a decisive separation of 15 per cent. phosphor-copper and the unphosphorised copper occurs. When the foregoing method is adopted, the product of phosphorisation is a black, brittle mass, and a bright lustre is exhibited on recently-fractured surfaces. A fact worthy of note is that phosphorised wire is occasionally hollow resembling tubes. Owing to incipient fusion due to the reaction the phosphor-copper may be withdrawn from this apparatus in lumps and utilised in this form, or it may be re-melted and cast in whatever suitable shape is required.

Uniformity of Composition Achieved.

Products taken from a number of heats made by the foregoing process were melted in crucibles and cast into ingots. A sample composed of portions taken from several ingots on being pulverised, mixed and analysed, showed 15.11 per cent. phosphorus. Analysis of pieces abstracted haphazard from the different heats demonstrated consistently uniform phosphorus content of 14.9 to 15.1 per cent.

In a number of heats red phosphorus was used, and a similar product obtained. Owing, however, to the considerably slower rate of volatilisation of red phosphorus (which may be heated to nearly 260 deg. C., without fusion), the rate of phosphorisation is proportionately less than when ordinary yellow phosphorus is introduced.

The seriousness of manipulating phosphorus near by molten metal cannot be too strongly emphasised, since even the heat of the hand is sufficient to ignite a piece of dry yellow phosphorus. Not only the danger but the wastefulness incurred by the direct introduction of phosphorus to molten metal has been the subject of numerous investigations resulting in new methods being applied for the production of phosphor-copper. The process already described, however, is superior to others in that no heat greater than 400 deg. C. is required for heating the copper. Manipulation of phosphorus in proximity to hot or molten metal is dispensed with, loss of phosphorus is eliminated, and a remarkably uniform production of 15 per cent. phosphor-copper obtained.

The Mellon Institute of Industrial Research.

Dr. E. R. Weidlein, the President of the American Institute of Chemical Engineers, who is also the Director of the Mellon Institute of Industrial Research, has recently visited England. Sir Alexander Gibb, G.B.E., the President of the Institution of Chemical Engineers, entertained him to dinner, to meet the Council of that Institution. Mr. F. H. Carr, President of the Society of Chemical Industry, and Mr. W. J. U. Woolcock were also among the guests.

Dr. Weidlein gave an interesting account of the history of the Mellon Institute, and stated that since 1920 it had been entirely self-supporting, the necessary funds being obtained by industrial firms, desirous of making use of its services, buying a Yearly Fellowship. So successful has the scheme proved that there is now a waiting list of firms desirous of purchasing these Fellowships.

Other outstanding features of the Institute, gathered from Dr. Weidlein's remarks, are that any discoveries and any patents which are taken out in connection therewith are the property of the firm holding the Fellowship in that particular research. An unwritten rule of the Institute is that the firms should reward the actual research worker for any successful exploitation of his work. The form of reward is at the discretion of the firm concerned, but so successful has been the system that permanent research workers of the Institute are often in receipt of yearly incomes from such firms which are larger than the salaries paid to them by the Institute. Cases have even been known in which the Institute has had to restrain the over-generosity of some firms.

The Institute does not fear the ultimate setting up of research laboratories by the firms themselves, for experience has shown that even if such laboratories are started, the firms are not only willing but anxious to continue their Fellowships, since they realise that the workers in the Institute, not being so vitally concerned with the problems of a particular industry, are able to take wider views of such problems than a firm's own workers.

At present 61 different investigations, covering an extremely wide field, are in progress, and the Institute is making large developments in the near future, so that it may be able to undertake fundamental scientific research as well as industrial research.

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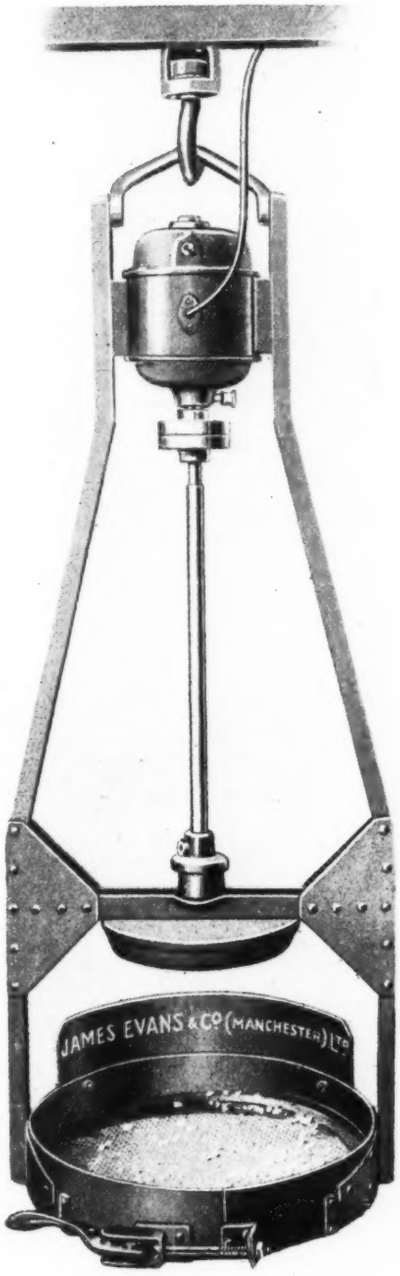

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The Mechanical Organisation of Foundry Work.*

By M. H. Magdelenat.

In opening his address M. Magdelenat stated that he had been requested to prepare a Paper on the mechanical organisation of foundry work by M. Ronceray, who assured him that the attention of their colleagues ought to be drawn to the question, "as the future of the country possibly depended on it." Since M. Ronceray had said this, it must be true, but at a time of acute crisis like the present it required a robust faith to remain convinced of it.

The organisation of foundry work led to the manufacture of castings in large numbers, and at present the position was such that customers showed little disposition to buy them. The French market did not at all resemble the American in this respect. In the French industry there were very few castings that could really be produced in quantity. The discussion of the question was nevertheless of interest, and the purpose of his remarks was merely to encourage such discussion.

Let them consider a hand moulder producing a casting in his individual shop. He had within reach his pattern, flask, and small equipment. The metal was brought to his shank, or he went and fetched it himself from the cupola. He moulded, cast, stripped, knocked off the runners, fettled his sand in it, sieved the sand on to the pattern prepared, rammed his mould accurately, and faced it with blacking to obtain as clean a casting as possible and of the minimum weight.

They must respect such a moulder. It was probable that for castings of average size he was still superior to the moulding machine, both in regard to weight and cost price as well as the quality of the work. They had been assured that even in the United States foundries doing hand work in the manner described were in at least as advantageous a position as regards selling as works organised for repetition work on a large scale.

Shortage of Moulders Explained.

Such moulders, however, showed a great tendency to disappear. Why was this? First of all, probably, because of the long apprenticeship. Not to mention machine moulding, which required several years, the moulding of repetition castings that were at all difficult required several months', and sometimes a year's apprenticeship. The work of the moulder as practised in the jobbing shops was very arduous. The castings, patterns and flasks were heavy to handle. The placing of them on the floor at a few yards' distance from the moulding point was often very hard work, and sometimes beyond the limits of normal exertion, or the effort which after a period of rest leaves no trace. Casting and stripping in the dust and steam were very trying, and in practice a moulder who poured in the middle of his working day felt a certain disinclination to recommence moulding until late afternoon. The hand moulder had also to stand the risk of losses, although after a certain there would be fewer workmen; the area of work-such losses to a trifle, often less than 2 per cent., a figure unknown in machine moulding. The use of blacking, too, was disagreeable.

Wherever such precious moulders existed it was necessary to preserve, encourage, and perpetuate them. Elsewhere circumstances necessitated their replacement by a mechanical organisation in which a man would learn his business in a couple of days, would perform a simple and indefinitely repeated task, would undergo no arduous exertion, but would display, without the loss of a minute, a high degree of activity from which he would derive greater advantage. The plant itself would have to undertake the transport of the flasks and sand and effect the ramming; it would have to facilitate the pouring and the stripping and provide for the complete preparation of the sand. Such an installation was extremely costly, although it was only right to set against this the reduction in the accessory charges of labour. Thus, there would be fewer workmen's houses, since there would be fewer workmen; the area of workshops would be increased, and so on. How could it be otherwise, seeing that the sand and the flasks, which in the individual workshop had to be moved only a few yards, would now have to travel 100 yards every time they were used?

But at least the plant, it was said, effected a reduction in the cost price. So far, nothing was less certain. The question, however, did not arise in that form. If they had working moulders they should have no mechanical organisation; if they did not have them, or not enough of them, mechanical organisation was indispensable. That situation had to be accepted.

A Railway Analogy.

This situation was not peculiar to foundry work. The railways were affected by it also. Supplying a locomotive with coal was an extremely simple operation; a wagon full of coal was put beside the engine, and a man with a shovel easily filled the tender. If they had to load 100 locomotives a day the yard would no longer be large enough; they had not 50 loaders or space for putting 50 locomotives in position for loading all at once. A mechanical system, at the outset confusing in its complexity, was required. The coal wagon, if provided with a movable bottom, was emptied into a trough distributor which took it to a conveyor belt or to a paternoster elevator. The coal was raised to a height of 10 metres, reaching a second distributor and the silo by means of a second belt, and was thence shot into the tender of the locomotive.

Such a plant cost millions of francs and required a very costly upkeep and very great motive power. But its utility was not questioned. If the cost per ton loaded was increased, that did not matter, for speed and certainty were essential. The shoveller threw in his load a distance of 3 metres superficially from a height of 2½ metres. The mechanism replacing him carried the coal 15 metres superficially from a height of 10 metres. To effect the oblique movement of the man five rectilinear or curvilinear movements and three motors were necessary. Five kilowatts scarcely sufficed to replace one man, and the kilowatt-hour cost one franc. In spite of themselves they were being impelled towards an increase in cost prices, and this—as G. Lenotre remarked in his delightful book "Gens de la vieille France"—possibly helped to explain the fact that they now paid 30 fcs. for a chicken which used to be worth 5 sous. Another example might be taken from agriculture. The harvester with his sickle and scythe was not beaten by machinery in regard to price; he was beaten in regard to time and output, and so he disappeared, although the reaping machine, which was used only a few days in the year, was an instrument which was used extraordinarily little.

In short, it was the number of castings to be produced which necessitated mechanisation and mechanical organisation—not the cost price. In France they had hand and machine installations working side by side which showed no difference in price for the two processes. It was all a question of production.

French Market Not Adapted for Mass Production.

The quantity and the rapidity required did not always justify mechanical organisation except beyond certain limits, below which machinery was not desirable and above which it might be more costly until the point was reached where it produced an advantage in regard to cost price. The desire of all who contemplated the introduction of mechanical organisation was therefore that customers should accept an identical article produced in large quantities. From this point of view the French market appeared specially difficult. Everybody wanted an article which was unlike that of his neighbour, and in regard to heating apparatus, for example, something was happening very much like what could be seen in the case of dressmakers who change their fashions every year. It was very regrettable, from their point of view, that they could not reverse this tendency. Founders were generally hostile to doing so themselves; they had not yet done anything to standardise their manufactures except as regards the trifling standardisation of the thread of kitchen taps, which was decided upon by the Association of Manufacturers of Heating and Kitchen Apparatus. But this appeared so far to have been carried into effect only to a very small extent.

When, he asked, would they come to an agreement whereby all castings common to apparatus would be identical, whether it was a question of washers, boilers, parts of fireplaces—in short, all castings which were subject to wear and tear, and which the housewife ought to be able to obtain at the nearest ironmonger's without being obliged to discover the origin of the apparatus requiring replacement or repair? Founders objected that such standardisation would bring about specialisation in the works. But this was precisely what would enable large series of castings to be manufactured by means of mechanical installations, to the great advantage of the consumer from the point of view both of price and of quality. There was yet another advantage in specialisation. In a heating apparatus it was not right to employ the same composition of metal for the front, the enamelled boiler and the grate. At least three qualities of metal were desirable. It was, however, practically impossible to provide these in works which manufactured the entire article. Before organising themselves mechanically, therefore, let them endeavour to standardise.

The mechanical organisation of moulding presupposed a minimum production of which large countries, such as the United States, would think nothing, since they had seen foundries where 700 tons and even 1,700 tons were cast in a day of two eight-hour shifts. In France the number of small foundries was considerable, and there were probably not many of them that could cast 3 tons per hour of the same casting. Three tons was about the production of the minimum cupola, so that it was at once obvious that mechanical plant ought to be adequate for several castings, and this was a first complication.

If the foundry was large enough it would have several mechanical installations or several parallel conveyors, and a cupola would serve them all simultaneously. Then, at the end of the day, it would supply the hand shops. It would appear, therefore, that without a minimum production of 3 tons per hour, *i.e.*, 24 tons per eight-hour day, it was not economic to instal one or more conveyors.

Construction of Mechanical Plant.

According to American practice it was now quite safe to rely upon a conveyor installation. Sand could be transported on cotton, rubber or steel belts, or moved in a satisfactory manner along the passages by scraper-conveyors. It could also be transported by grabs. The general plant comprised, in principle, a conveyor or a haulage roller along which the moulding machines and the men finishing, casting and stripping the moulds would be placed. The workmen did not change their position; special conveyors supplied them with the flasks, the facing sand and the backing sand from suitable hoppers. The sand deposited beside the machine was carried down to the lower floor where it was taken back to the sand shop by scrapers. Stripping was effected either by hand or on a jar-machine table, on the same level as the moulding shop, or preferably on a higher floor so as to avoid the production of steam in the shop. The finished casting was carried off by a conveyor: the sand fell on to the lower floor into a distributor from which it was carried on a rubber or other belt to the sand shop.

In their industry in France men were more to be desired than machines, but as this desire was not likely to be fulfilled soon they must resolutely take up the mechanical organisation of foundry work, preceded by standardisation, and also agitate for the suppression of the turnover tax, which was anti-industrial, anti-commercial and detrimental to industrial exchange.

* Translated from the Bulletin of the Association Technique de Fonderie. The author is Managing Director of the Société des Fonderies de Rosières (Cher) and Vice-President of the Association.

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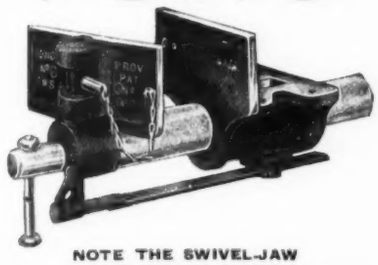

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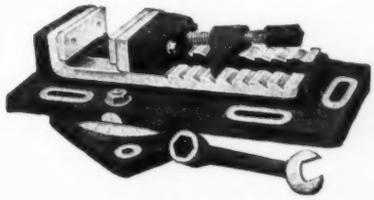

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Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Nomenclature.

To the Editor of The Foundry Trade Journal.

Sir,—Owing to absence I have only just seen Mr. Hurst's letter in your issue dated October 6, 1927, on the subject of his Spun Sorbitic Iron, and I should be much obliged if you could allow me a short space for comment.

Unfortunately I am not a metallurgist, but I am advised that sorbitic pearlite is a material of a somewhat indefinite composition. We have produced iron containing sorbitic pearlite for several years, and our contention is that there is nothing distinctly novel in the production of such iron when made by the centrifugal-casting process. On examining the published photographs of the so-called spun sorbitic iron, I must say that the matrix appears to be laminated pearlite, and somewhat broken up as is usual with cast iron when centrifugally cast.

Also I cannot quite understand why there should be this thirst for named varieties. Surely our industry is complicated enough without our endeavouring to copy the Dutch bulb catalogue in their endeavours to produce a long list of named varieties. Mr. Hurst sees a casting apparently showing sorbite through his microscope, and lo, it immediately becomes Spun Sorbitic Iron.

I cannot see what the industry has to gain by this passion for special names, but if there is going to be competition in the matter I hereby lay claim to having produced "Spun silico-ferritic iron," "Spun troostitic iron," "Rotary Austenitic Iron," "Migratory Martensitic Iron," "Spun latticed ternary-eutectic iron," "Spun troosto-sorbitic iron." All these things have we spun, and shall hope to continue to spin.—Yours, etc.,

The Sheepbridge Centrifugal Castings Company, Limited.
F. W. Stokes,
Managing Director.

Chesterfield.
October 26, 1927.

Britain's Largest Aluminium Casting.

The casting shown in the accompanying photograph was cast recently in the foundry of Messrs. D. and J. Tullis, Limited, Kilbowie Ironworks, Clydebank. It was cast in an aluminium alloy of S.G. 2.9, and weighs 2¼ cwts. It is claimed

that this is the biggest aluminium casting yet made in Great Britain.

[We are not at all convinced that the above represents the largest so far cast, and would welcome correspondence on the subject.—Editor.]

Random Shots.

Well-informed visitors returning from the United States have some interesting comments to make on American aerial developments. Passenger flying there appears to lag far behind this country, and, indeed, Europe generally, owing to the relative cheapness of railway travel, its comfort and popularity in the States. On the other hand, a great many business houses are apparently running their own 'planes, and they claim that this effects real economy, especially where the time of highly-paid officials is concerned. It is doubtful how far such an innovation would be successful over here; the distances we have to cover are so much less formidable, our roads and road transport facilities so much better. There would, moreover, be the further difficulty of finding landing space within convenient distance of works in any of our important industrial areas—a complication which presumably does not arise in America, where there is an almost endless reservoir of land to draw upon.

* * *

Once upon a time it was customary in hot climates for those who could afford it to employ a slave or servant to fan them ceaselessly. Nowadays we can buy electric fans in bewildering variety. Once upon a time cleaning was done amidst a cloud of dust with a brush and pan and elbow grease; now we use a vacuum cleaner. And it seems that the awful march of progress is not yet at an end, since our enterprising daily Press assures us that before long we shall see the electric servant being brought to perfection. . . . Imagination baulks at the prospect of further advance; does this mean that some day, for instance, we shall be able to employ electric substitutes, who can attend to our business for us while we lie abed, or disport ourselves at "the Dogs," or wherever else fancy may dictate? The vision of a long line of electric moulders and cupola-men clocking in and taking instructions from an equally electric foreman, makes the brain reel. . . .

* * *

Now that the season for all three may fairly be said to be over, one wonders which of our new sports is likely to prove the most permanent. Long-distance flying had, one felt, been given its quietus by a series of disasters, but the recent musical-comedy attempt, with a sensational escape for climax, has somewhat lightened the atmosphere, although one welcomes the news that a Safe Aircraft Competition is to be held in New York in 1929. Channel swimming, after waiting vainly for many months, came into its own at the tail end of the season with a bump, and monopolised public attention, in this country at least, for long enough to satisfy the most ardent enthusiast. As for "the Dogs" . . . . in some parts of the country they are to disport themselves all winter: elsewhere one hears that far-sighted promoters have decreed a closing-down for some months—not merely, we suspect, on account of the weather—greyhound racing has, after all, already stood the severe test of the rigours of an English summer—but for no less urgent reasons of policy. A period of enforced abstention at this stage may well be the determining factor in next year's popularity.

* * *

When will our enterprising Corresponding Colleges honour us with some such advertisement as this:—

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A. (Middlesbrough) writes:—"Since I began your course the foreman has invariably treated me with marked respect."

B. (Falkirk) writes:—"As a result of taking your course I have been able to reduce melting costs to such an extent that we are producing one ton of metal at the cupola spout with ½ cwt. of coke."

C. (Llanelly) writes:—"By the third week of your course my flow of language was sufficient to influence the managing director in my favour to the tune of a 300 per cent. rise."

The originals may *not* be seen at our office.

Marksman.

I.B.F. Section Presidents.

No. 2: Sheffield.

Mr. Ambrose Firth is a director of the Brightside Foundry and Engineering Company, Limited, Sheffield. He is a grandson of Mr. Ambrose Firth, who founded the company more than 50 years ago, and is the son of the late Mr. Thomas Henry Firth, the late Chairman of the company, and a past President of the Institute.

Mr. Firth was educated at Rugby, and, on leaving there, joined the firm with which his family has been for so long identified. As part of

Mr. Ambrose Firth,
President of the Sheffield Section of the I.B.F.

his apprenticeship course, he spent nine months in the engineering shops of a firm in Germany. During the war he served with the 4th York and Lancaster Regiment, holding commissioned rank, and afterwards transferred to the Royal Flying Corps, being first an observer and later an instructor, and served in France with both units.

After the war Mr. Firth returned to the firm and was made a director soon afterwards.

He is one of the many young business men in Sheffield who are filling prominent places in the industrial life of the city. The foundry with which Mr. Firth is connected is the largest iron foundry in Sheffield.

Far Eastern Foundry to Extend.

Messrs. Jarnee and Company, of Singapore, are extending their foundry and ask for catalogues dealing with ladles, electric cranes of 1-ton capacity, electric welding equipment, pneumatic tools, small moulding machines, refractory sands and clays and the like.

ALUMINIUM ALLOYS
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(Part of) Aluminium Data Sheet A 121

Specification. No.	Specified Chemical Composition.[1]	Description.	Minimum Tensile Properties.[2] Ultimate tens. str. Tons sq. in.	Per cent. elongation in 2 in.
3L11	*Copper* 6% to 8% ... *Tin* may be used up to 1%	Casting alloy	9	3
2L8	*Copper* 11% to 13% ...	Casting alloy	9	Nil
2L5	*Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ...	Casting alloy	11	3
L24	*Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7%	"Y" alloy castings	11	Nil

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .564 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width ½in. to 1½ in., and parallel length 2½ in.

F.T.J. 18/6/27.

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Trade Talk.

THE BUSINESS HITHERTO carried on by Grant, Ritchie & Company, Townholm Engine Works, Kilmarnock, is being offered for sale.

A FIRM IN THE MIDLANDS has just placed with Mr. C. W. Coleman, of 10, Savoy Street, Strand, London, W.C.2, an order for the largest split machine ever built in Great Britain.

THE MOUNTSTUART DRY DOCK AND SHEARMANS, LIMITED, propose reverting to the shorter title of Mountstuart Dry Docks, Limited, by which name the company was formerly known.

THE AYRESOME IRONWORKS of Gjers, Mills & Company, Limited, Middlesbrough, which have been idle for many months, were restarted on October 24, two blast furnaces being put into operation out of five at the works.

THE LLANELLY STEEL COMPANY, LIMITED, are laying down new sheet mills on ground adjoining their existing works, and are also providing a new bar mill. The sheet plant comprises six mills, and will be put into operation within a few weeks.

MESSRS. J. PITCHFORD and J. Walker, iron and steel founders, trading under the style of the Wilford Malleable Steel Castings Company, The Foundry, Southampton Street, Wolverhampton, have dissolved partnership. Mr. J. Pitchford retires from firm.

THE PLANT OF Manning, Wardle & Company, Limited, Boyne Engine Works, Jack Lane, Leeds, which has been in the market for some time, is being dismantled by Thos. W. Ward, Limited, of Sheffield, who have recently acquired many large works.

THE STANDING COMMITTEE (General Merchandise) appointed by the Board of Trade have reported on their inquiry as to whether imported brass-water taps and fittings, electrical accessories, etc., and imported rubber tyres and tubes should be required to bear an indication of origin.

IN A PAPER ON "British Engineering Export Problems," read at a meeting in Glasgow on October 18, of the Institution of Engineers and Shipbuilders, Mr. W. S. Murphy dealt with the question of British engineers and shipbuilders competing with their rivals in other nations in salesmanship.

AT THE OPENING MEETING of the session of the West Cumberland Society of Chemists and Engineers, held at Workington, Mr. S. J. Dale, technical secretary of the British Refractories Research Association, gave an interesting lecture on "Refractory Fire Clays and Materials used in the Manufacture of Bricks."

AN EXCELLENT PERFORMANCE was accomplished at Sir W. G. Armstrong, Whitworth & Company's shipyard, Wallsend-on-Tyne, on October 24, when within five minutes of the launch of the "Varand," 8,500 tons deadweight, building for the Baltic Trading Company, Limited, the keel plates of a sister ship for the same owners were laid.

THE WORKS AND IRON FOUNDRY of Sandicroft, Limited, on the banks of the Dee, near Chester, were offered for sale by auction. No offers were made for the works as they stood, but bidding was brisk when the auctioneers commenced selling the plant and machinery separately. The disposal of this means the death knell of an industry which won engineering fame for Flintshire in many countries.

ALFRED HERBERT, LIMITED, Coventry, have purchased the goodwill, drawings, patterns and other assets of the Hey Engineering Company, of Hendon, Middlesex, who have specialised in high production drilling machines, milling machines, multiple drill heads, jigs, fixtures and other equipment for repetition work. Mr. George Hey has joined the staff of Alfred Herbert, Limited, and will assist them in the development of machines and equipment for dealing in the most economical manner with quantity production.

MR. W. R. BELL, assistant manager of the London and North Eastern Railway, in an address to the company's debating society at York, drew a very unfavourable comparison between the handling of goods traffic in this country and the work of the American railways. For example, he stated that the average movement of wagons here was only 10½ miles per day and that their wheels only turned 1½ hours out of every 24. Further, with an average wagon capacity of 10⅔ tons the average load was only 5½ tons, while the average speed of the freight trains was 8½ miles an hour. At the beginning of this year the American railways succeeded in bringing their average car mileage to 30.2 by increasing the number of cars to each train and working up the speed to 12½ miles an hour. Mr. Bell pointed out that if our railways were to increase the average load of the wagons by one ton it would be equivalent to an addition of 250,000 wagons—worth about £40,000,000—to the railway stock of Great Britain. There was no mistaking, Mr. Bell said, the call to the railways to accelerate freight movement.

A WORLD CONFERENCE on engineering matters is to be held in Tokyo for two weeks towards the end of October, 1929. The Kozakkai, the Japanese Engineering Society, are to be the hosts, whilst the Government is helping with a large monetary grant.

IN HIS PRESIDENTIAL ADDRESS to the West of Scotland Iron and Steel Institute, at a meeting in Glasgow on October 21, Mr. John Craig dealt with the present position of the steel industry, and examined the reasons why British steel prices were higher than Continental. After referring to the importance of research, a branch of work which had been interrupted by the war and the succeeding depression, Mr. Craig said it appeared to him there had not been sufficient attention paid to increased uses of steel. It should be possible, for example, largely to increase the use of steel in and around collieries. The leaders of the steel trade in Germany had recently submitted a considered opinion to their own Government that if they carried out the threat to introduce the eight hours day into Germany as it applied to Britain it would cause an increase in their costs of at least 10s. per ton. Some time ago the balance-sheets of twelve of the largest public companies in Britain were examined, and it was found that their debenture interest alone on the output of 1925 was 7s. 3d. per ton on their ingot production, but if they took the record output of the first six months of 1927 the amount was reduced to 5s. 10d. per ton. This was an item which had nearly disappeared from the German cost-sheet. If they made a further addition of what it was estimated the social services in this country cost in excess of those which were current on the Continent, they had another figure of probably 4s. per ton. These items alone reached nearly 20s. per ton, but there still remained the enormous cost of transport in this country compared with the smaller cost on the Continent. It was difficult to assess the actual amount, but it might be assessed to be at least 5s. to 7s. 6d. per ton. There was also to be recorded the lower wages that were current. Recent investigations by the Iron and Steel Federation revealed that wages in Germany were to-day only 70 per cent. of those in Britain, and 60 per cent. in the cases of France and Belgium.

Obituary.

MR. C. R. COMMON, of Heresford Park, Sunderland, whose death is announced, was 46 years of age, and carried on the business of an iron and steel merchant established by his father.

THE DEATH HAS TAKEN PLACE of Mr. Richard Charles Lindop, J.P., of Sunnyside, Grove Road, Fenton, at the age of 62 years. For many years Mr. Lindop was cashier, secretary and ultimately managing director of the Manor Engineering Company at Fenton, which was formerly carried on by Mr. William Hill.

MR. WILLIAM CHAMBERS, of the Material Services Corporation, Chicago, died in that city last September, aged 83. Mr. Chambers was born in England, and made a point of welcoming British visitors to the annual congresses of the American Foundrymen's Association. He was universally known in foundry circles as "Uncle Billy."

SIR GERARD ALBERT MUNTZ died suddenly at his residence, Tiddington House, near Stratford-on-Avon, on October 22. He was the eldest son of the late Sir Philip Albert Muntz, and succeeded to the baronetcy in 1908. Educated at Harrow, Victoria College (Manchester), Neuwied (on the Rhine), and King's College (London), Sir Gerard Muntz afterwards devoted himself to the metal industry, and from 1896 to 1921 was managing director and consultant director of Muntz's Metal Company, Limited. In connection with his business interests he made an exhaustive study of the properties of copper, copper alloys, and other non-ferrous metals; and he also investigated the deterioration of brass condenser tubes and the chemical and electrolytic action of seawater on sheathing. The results of those studies were embodied in the numerous articles he contributed to technical papers and in papers he read before professional organisations. His eminence in his own field was reflected in the offices he was from time to time called upon to fill. He was president of the Institute of Metals in 1910-1911, chairman of the Associated Manufacturers of Brass and Copper Tubes of Great Britain, chairman of the Brass and Copper Tube Association, 1900-1921, and chairman of the Metallurgical Section of the Department of Scientific Research. He was also a member of other bodies associated with the metal industries, including the Institute of Mechanical Engineers, the Alloys Research Committee, the Corrosion Committee of the Associated Scientific Institutions and Societies of Great Britain, and the Council of the Birmingham Chamber of Commerce. From 1915 to 1917 he was chairman of the Non-Ferrous Trades Committee, and after the war he served on the Committee on Trade and Commercial Policy.

Personal.

MR. W. MORRIS, Redcar, has been elected a director of the Anderston Foundry Company, Limited, Middlesbrough.

MR. JAMES BROWN, managing director of Scotts' Shipbuilding and Engineering Company, Limited, has been installed president of the Greenock Association of Engineers and Shipbuilders for the ensuing year.

SIR EUSTACE H. TENNYSON-D'EYNCOURT, previously managing director of Sir W. G. Armstrong, Whitworth & Company, Limited, has been elected a director of the Parsons Marine Turbine Company, Limited.

MR. ROBERT BLACK, of 35, Robertson Street, Glasgow, C.2, has been appointed sole representative in Scotland for the sale of machine-moulded gears and general castings made by Joseph Henry, Limited, Manor Road Foundry, Manor Road, Leeds.

MR. P. C. DICKENS, grandson of the famous novelist, has resigned his position as secretary of the Synthetic Ammonia and Nitrates, Limited, of Billingham-on-Tees, to take up an appointment with the Imperial Chemical Industries in London.

MR. FRANK J. REES, J.P., managing director of the Llanelly Steel Company, Limited, has been elected chairman of the South Wales Siemens Steel Association, in succession to the late Sir J. C. Davies. He has been vice-chairman of the Association for some time.

MR. E. C. SPRAGUE, vice-president of the Acheson Graphite Company, of Niagara Falls, is at present making one of his biennial business tours of Europe. Mr. Sprague was domiciled in London for several years, and possesses a large circle of friends in Great Britain. Letters addressed to him care of Messrs. E. G. Acheson, Limited, of 40, Wood Street, London, S.W.1, will be forwarded.

SIR SAMUEL ROBERTS, Bt., M.P., of Cockley Cley Hall, Swaffham, Norfolk, has been elected a director of the British Wagon Company, Limited. Sir Samuel is on the boards of Grayson, Lowood & Company, Limited, and the Wombwell Main Company, Limited. The vacancy had been caused by the death of Mr. F. L. Harrop, who for many years served as chairman, and who was succeeded, on his retirement from that position, by Mr. T. R. Chislett.

Wills.

WHITEHEAD, A. V., a director of the Whitehead Iron & Steel Company, Limited... £59,144

WHITE, J., a partner in John White & Sons, weighing-machine manufacturers, of Edinburgh £20,879

DAWSON, G. W., Linthorpe, Middlesbrough, a director of the Anderston Foundry Company, Limited, Port Clarence £9,062

ELY, Colonel H., of The Bungalow, Iverley, Stourbridge, formerly manager of George Salter & Company, Spon Lane Foundry, West Bromwich £8,810

TAYLOR, P., Loughborough, a member of the bell-founding firm of John Taylor & Company, and a director of Gillett & Johnston, Limited, of Croydon £10,626

Contracts Open.

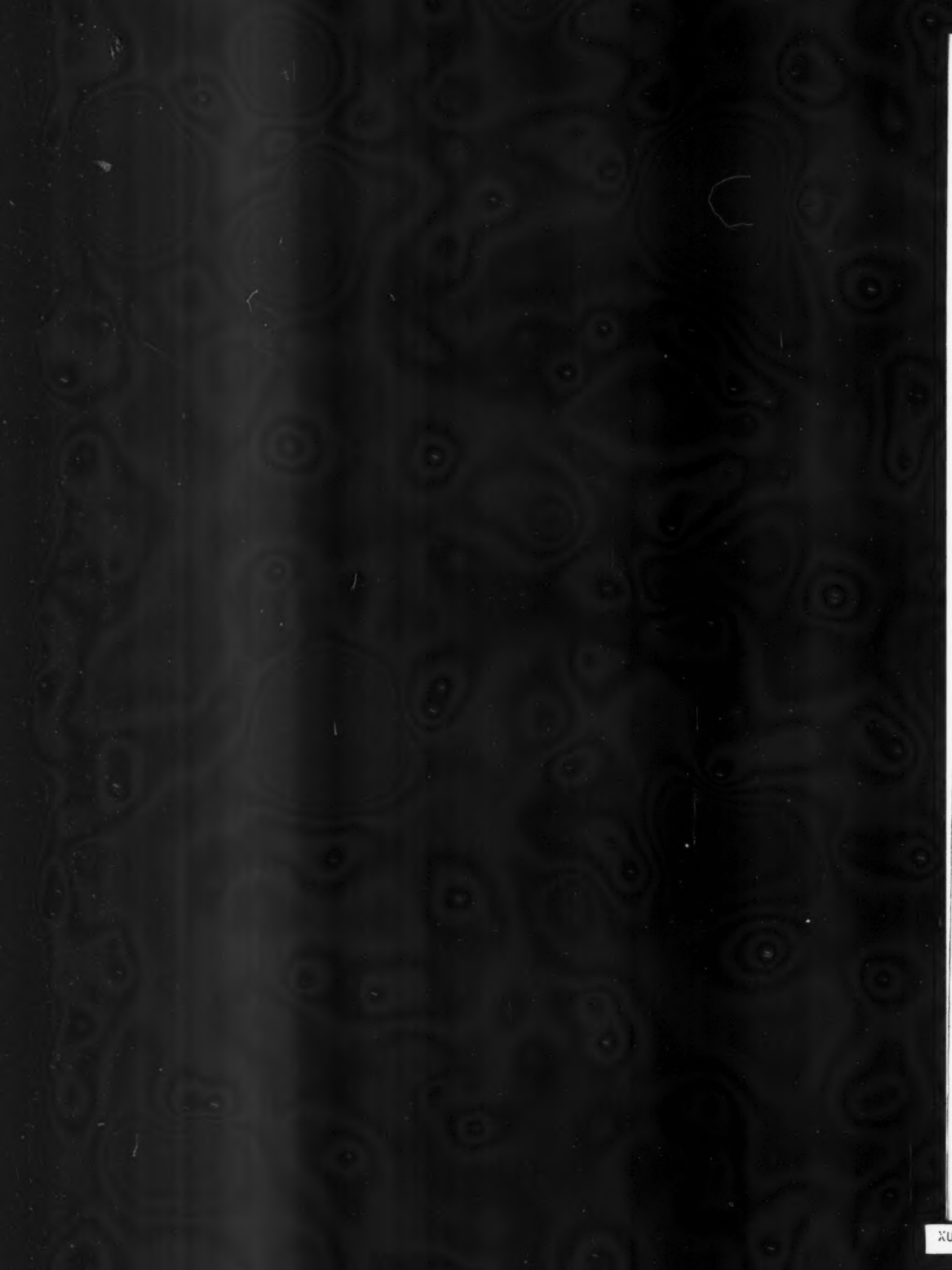
Doncaster, November 15.—2¾ miles of 21-in. diam. and 1½ miles of 24-in. diam. cast-iron rising and gravitation mains or steel mains, for the Corporation. Mr. F. O. Kirby, borough engineer, 2, Priory Place, Doncaster. (Fee £5 5s., returnable.)

Dublin, November 8.—Axles, brakes and tyres; bolts, nuts, screws, nails; brass goods; castings; cables; iron and steel; springs; steam fittings, for 12 months ending December 31, 1928, for the Dublin United Tramway Company (1896), Limited, 59, Upper Sackville Street, Dublin. (Fee 2s. 6d.)

Dublin, November 12.—(3) Copper tubes, block tin, zinc, spelter, etc.; (13) brass fittings; (20) lead (ground-in-oil and dry), sheet, etc., for six or twelve months from January 1, for the Great Northern Railway (Ireland). Mr. F. C. Wallace, secretary, Amiens Street Station, Dublin. (Fee 1s. each.)

Londonderry.—72 2½-in. sluice valve hydrants, for the Corporation. Mr. M. A. Robinson, city engineer and surveyor, Guildhall, Londonderry.

Welwyn, Herts, November 14.—10,800 yds. of 6-in., 4-in. and 3-in. cast-iron water mains, complete with valves, water tower, etc., for the Rural District Council. Messrs. D. Balfour & Son, civil engineers, 18, Abingdon Street, Westminster, London, S.W.1. (Fee £5.)



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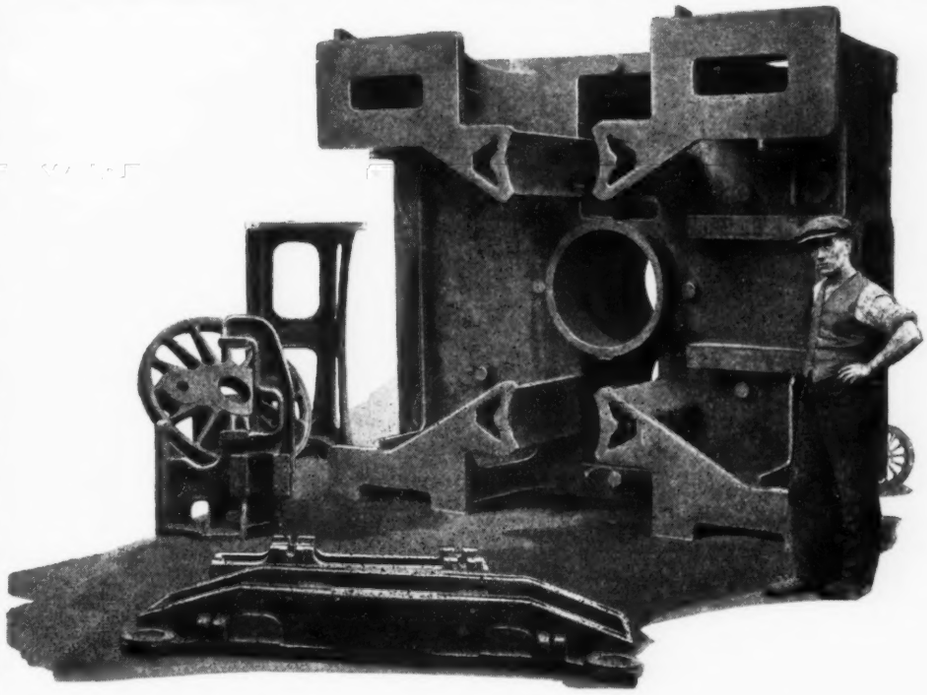

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Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—The month just ended, it must be admitted, has hardly realised expectations of increased trade activity in Cleveland iron markets, as confidently anticipated earlier in the quarter, with business on the whole somewhat below the average tonnage usual at this period of the year. Shipments of pig-iron from the Tees also to date are in disappointing contrast to the September figures, while foreign cargoes are still arriving in substantial quantities in home ports, and Scotland is still drawing the bulk of its supplies of foundry iron from Antwerp, at a saving of several shillings per ton. At present Cleveland iron can only be sold to Scottish consumers, who are prepared to pay a preferential price, and producers who usually have regular shipments to Grangemouth have almost entirely lost the connection. However, events may speedily turn in their favour. On 'Change last week there was a report, at present lacking confirmation, that Continental producers are cutting home prices and stiffening export prices. A movement in that direction would be distinctly favourable to Tees-side producers, and again place Cleveland iron in a dominating position in the home market. Meantime, current quotations remain unchanged as follow:—Home trade: No. 1 Cleveland foundry iron, 70s.; No. 3 Cleveland G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. For export and to Scotland prices are all 2s. 6d. per ton below the quotations mentioned.

In the hematite section, the additional plant just started has increased output fully to the extent of existing demand for home requirements, and in the case of export orders competition continues very keen, with considerable price-cutting by sellers. However, for home orders makers are showing a disposition to resist further price-cutting, and 72s. per ton for mixed numbers and 72s. 6d. for No. 1 are fairly generally being adhered to. On the North-West Coast, mixed numbers are quoted at 72s. 6d. to 73s. 6d. per ton at works, and special iron is now only 2s. 6d. per ton above these figures.

LANCASHIRE.—Markets for foundry pig in this area continue steady, with a firmer tendency in prices for the leading Midland brands. The quotation of 74s. per ton, delivered Manchester or equal distance, for Derbyshire No. 3 foundry iron is now fairly general. Staffordshire iron is held for about 73s. 9d. and Cleveland for 80s. 8d., but Scottish brands for local delivery are on the easy side at 89s. to 90s. per ton.

THE MIDLANDS.—Makers of foundry pig in the districts supplying local markets continue firm in prices quoted, and at the moment there seems little disposition on the part of sellers to make further concessions in order to secure business. No. 3 Derbyshire is quoted at 66s. and 67s. f.o.t., Northants No. 3 from 60s. to 61s. f.o.t., Staffordshire No. 3 about 65s. at furnaces, and equal quality Scotch at 90s. to 92s. 6d. delivered.

SCOTLAND.—Demand for foundry pig on Clyde-side and other northern centres of the industry continue much below the usual average, with prices inclined to ease on the basis of 72s. 6d. per ton f.o.t. furnaces for No. 3 quality. There is no hint of further reductions in the make meantime, but unless there is a change for the better, a continuation of the present conditions is bound to force makers to further reduce the production.

Finished Irón.

Production of most classes of finished material is, generally speaking, in an unsatisfactory condition, the volume of business reported weekly continuing much below the average for this period of the year. At Birmingham last week demand remained unsatisfactory in regard to crown and cheaper iron, and it is only in connection with marked bars that there are signs of activity and improvements. The price of Staffordshire marked bars remains at £13 at makers' works. The position concerning crown iron prices is somewhat peculiar, as this iron has been sold at under £9 10s. delivered this area from works outside the Staffordshire district, and there are also cases of Staffordshire works taking well below £10. The average local quotation, however, is between £10 and £10 5s. Little support is forthcoming at these prices, and still less for nut and bolt iron, which is quoted at about £9 per ton. The Belgian No. 3 iron is still offered at very low figures, and under £5 15s. delivered works here would be taken for quite moderate tonnages.

Steel.

Conditions in the steel industry continue unsatisfactory, orders of any magnitude being limited in volume at the moment, while foreign competition still severely handicaps home producers. Current prices for English billets are irregular at from £6 delivered, and Welsh supplies of sheet bars and billets at about £5 15s. to £5 17s. 6d., delivered the Midlands. With regard to Continental semis supplies of billets can be readily obtained at £5 3s. 6d. per ton, sheet bars at £5 6s. per ton, and blooms at £4 19s. per ton. All these figures are delivered works in the Black Country for soft Thomas quality. A few speculative transactions have been made at slightly under these levels. The demand for tinplates is far from satisfactory, but a little more business has been done. Competition for orders is very keen, and orders have been taken at figures which do not cover cost of manufacture.

Scrap.

From acute depression to comparative activity may be the best description of existing conditions in the markets for scrap metals, and, as applied to the section dealing with foundry material, only a moderate average of business is actually transacted. In the Midlands, however, there has been a slight improvement for cast-iron scrap, and for machinery quality in cupola sizes 70s. to 72s. 6d. per ton delivered is quoted, with 55s. per ton delivered for lighter material. In Yorkshire sales of heavy cast-iron scrap have been effected at 65s. per ton delivered for machinery quality. In Scotland, machinery cast-iron scrap in furnace sizes remains unchanged around 67s. 6d. per ton, with 5s. per ton less for ordinary qualities. There is also a better demand for light cast-iron scrap at about 57s. 6d. per ton, all delivered f.o.t. consumers' works.

Metals.

Copper.—The upward trend of values for warrant copper continues the most prominent feature in markets for base metals, prices during the past week having appreciated to a substantial extent, an improvement of nearly £3 being recorded at the close. The upward movement may be attributed to the large decrease in stocks of rough copper in this country, together with reports of active Continental buying, and more encouraging advices from America.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £56 7s. 6d. to £56 8s. 9d.; Friday, £56 7s. 6d. to £56 8s. 9d.; Monday, £56 11s. 3d. to £56 12s. 6d.; Tuesday, £57 to £57 1s. 3d.; Wednesday, £57 17s. 6d. to £57 18s. 9d.

Three Months: Thursday, £56 7s. 6d. to £56 8s. 9d.; Friday, £56 7s. 6d. to £56 8s. 9d.; Monday, £56 11s. 3d. to £56 12s. 6d.; Tuesday, £56 18s. 9d. to £57; Wednesday, £57 13s. 9d. to £57 15s.

Tin.—Rumours of a price stabilisation scheme recently circulated in the Press have been freely discussed in the tin market circles, but without much effect so far on business in general, which continues fairly steady. Members of the Metal Exchange do not, apparently, take the proposal seriously, and have even gone to the length of issuing a warning that any affect that the reports may have on the market will not be warranted. Apart from these rumours, the tone of the market is stronger, and it is anticipated that there may be an improvement in the American demand, especially for the motor-car industry.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £264 15s. to £264 17s. 6d.; Friday, £262 7s. 6d. to £262 12s. 6d.; Monday, £261 10s. to £261 15s.; Tuesday, £259 12s. 6d. to £259 17s. 6d.; Wednesday, £258 5s. to £258 10s.

Three Months: Thursday, £261 10s. to £261 15s.; Friday, £259 15s. to £260; Monday, £258 12s. 6d. to £258 15s.; Tuesday, £256 15s. to £257; Wednesday, £255 15s. to £256.

Spelter.—The market for ordinary spelter remains uneventful, the chief consuming industry still continuing very poorly employed. At the same time, supplies have not been pushed on the market, and stocks of the high-grade material are by no means heavy. Some inquiry has resulted from the Continent, and this gives a rather stronger appearance to the market, but latterly values have developed some weakness.

The following are the week's prices:—

Ordinary: Thursday, £26 11s. 3d.; Friday, £26 15s.; Monday, £26 12s. 6d.; Tuesday, £26 10s.; Wednesday, £26 10s.

Lead.—Business in soft foreign pig may be regarded as slightly improved, with values a shade stronger than of late. Strictly speaking, the situation, by reason of the heavy stocks, high production, and indifferent demand on the part of consumers, does not warrant sustained improvement, which can only result from genuine industrial development and consequent substantially broadening demand on the part of the consuming industries.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 11s. 3d.; Friday, £20 15s.; Monday, £20 16s. 3d.; Tuesday, £20 15s.; Wednesday, £20 10s.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Many thanks for inserting my letter. I have indeed received many helpful letters, and shall be obliged if you will kindly acknowledge through the medium of your paper my thanks to all who have sent letters and information dealing with my inquiry. I shall be acting on the advice given and will have pleasure in informing you how the experiments succeed.

It is very difficult to run a foundry such as ours on modern lines. The foundry is but a small part of our works, and the variety of work is very great. We run about three tons once every week or ten days, and the run consists of pretty nearly everything—stove plates, heavy sugar rollers, pulleys, toothed wheels, pots, bedstead stocks, fine ornamental work for gates and balconies, etc.—so you can appreciate how difficult it is. On top of this one has to translate all instructions into Portuguese—no slight undertaking, as the workmen are very conservative, and when they do not wish to understand you they are very stupid. Then there is the fluctuating exchange, which upsets costing. Still, the life here has its compensations. There is an absence of the rush and tear of modern city life; no trains to catch or trams and 'buses to dodge, and life jogs along very smoothly. We are now enjoying, or otherwise, a very warm time; duck suits are essential, but seem out of place in the works, but it is remarkable how one soon adapts oneself to the conditions.—Thanking you again for your kind assistance,—Yours, etc.,

Jos. H. QUICKE, A.M.I.Mech.E.
The Madeira Supply Co., Ltd.,
4, Rua da Pont de S. Lazaro, Madeira,
August 10, 1927.

Foundry Queries.

Electric Furnaces for Aluminium.

I should be much obliged if you, or any of your readers, could inform me of the best type of electric furnace for melting aluminium alloys. The metal is to be used for automobile castings which have a high duty to perform, therefore freedom from gas holes and oxides is essential.

I am informed that electric furnaces for the melting of aluminium alloys have got beyond the experimental stage, and I should be very grateful for any information you could give me on this subject. In view of the extensive use of light alloys in the engineering trade at the present time I feel sure that an electric furnace capable of easy control, impossibility of overheating, and the maintenance of a neutral atmosphere is an established fact, and particulars of such a furnace will be much appreciated.

LIGHT ALLOY FOUNDER.

Brand of Iron Wanted.

Could you help us with regard to an inquiry concerning "Vulcanus" iron? The name is a new one to us, and we are anxious for particulars of this metal which is being considered for special high-grade classes.

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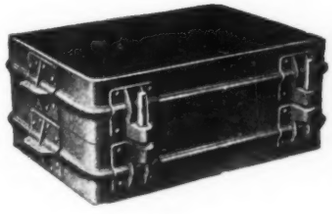

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Guaranteed absolutely rigid.

Made to any desired limits of accuracy.

Cannot crack or break.

Cannot distort or get out of shape.

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WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	57 17 6
Three months	57 13 9
Electrolytic	62 17 6
Tough	61 0 0
Best selected	61 15 0
Sheets	86 0 0
India	71 10 0
Wire bars	62 17 6
Do. November	62 12 6
Do. December	62 12 6
Ingot bars	62 12 6
H.C. Wire rods	67 10 0
Off. av. cash, Oct.	55 3 0½
Do. 3 mths., Oct.	55 5 3-⅜
Do., Sttlmnt., Oct.	55 2 11⅝
Do., Electro, Oct.	62 8 9
Do., B.S., Oct.	61 18 9
Aver. spot price, copper, Oct.	55 2 11¾
Do., Wire bars, Oct.	62 12 4¾
Solid drawn tubes	12½d.
Brazed tubes	12½d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9¼d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d

TIN.

	£ s. d.
Standard cash	258 5 0
Three months	255 15 0
English	257 10 0
Bars	261 5 0
Straits	267 5 0
Australian	264 15 0
Eastern	262 5 0
Banca	270 15 0
Off. av. cash, Oct.	264 15 0½
Do., 3 mths., Oct.	261 16 4½
Do., Sttlmt., Oct.	264 14 9¼
Aver. spot, Oct.	264 15 0¾

SPELTER.

	£ s. d.
Ordinary	26 10 0
Remelted	25 0 0
Hard	20 10 0
Electro 99.9	30 5 0
English	26 17 6
India	22 10 0
Zinc dust	35 0 0
Zinc ashes	9 0 0
Off. aver., Oct.	26 15 3-¾
Aver., spot, Oct.	26 17 11¾

LEAD.

	£ s. d.
Soft foreign ppt.	20 10 0
English	22 0 0
Off. average, Oct.	20 14 3½
Average spot, Oct.	20 9 7

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	36 0 0
Do. V.M. ex whf.	34 10 0
Rods	42 0 0
Boiler plates	34 0 0
Battery plates	33 10 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	64 10 0
Chinese	43 0 0
Crude	37 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%..	8 17 6
45/50%	12 15 0
75%..	20 0 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11½d.
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 2 6
6/8% car.	£22 17 6
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£35 17 6
Max. 1% car	£41 12 6
Max. 0.70% car	£53 0 0
70%, carbonless	1/4 lb.
Nickel—99%, cubes or pellets	£170 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80%, loose	£13 0 0
76/80%, packed	£14 0 0
76/80%, export	£11 10 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	2 17 6 to	3 0 0
Bundled steel and shrngs.	2 12 6 to	2 16 6
Mixed iron and steel	2 12 6 to	2 14 0
Heavy cast iron	2 17 6 to	2 19 0
Good machinery for foundries	3 2 6	
Cleveland—		
Heavy steel	2 17 6	
Steel turnings	2 5 0	
Cast iron borings	2 2 6	
Heavy forge	3 12 6	
Bushelled scrap	3 2 6	
Cast-iron scrap	3 1 0 to	3 5 0
Lancashire—		
Cast-iron scrap	3 5 0	
Hvy. wrought	3 2 6	
Steel turnings	2 2 6	

London—Merchants' buying prices delivered yard.

Copper (clean)	48 0 0
Brass (clean)	37 0 0
Lead (less usual draft)	18 10 0
Tea lead	16 10 0
Zinc	16 10 0
New aluminium cuttings	76 0 0
Braziery copper	45 0 0
Gunmetal	46 0 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	72/6
Hematite M/Nos.	72/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	92/-
Midlands—	
Staffs. common*	—
,, No. 4 forge	62/6
,, No. 3 fdry.	65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/6
,, fdry. No. 3 60/- to	61/-
Derbyshire forge	60/6
,, fdry. No. 3	66/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	72/6
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	65/-
,, fdry. No. 3	68/-
Lincs. forge	—
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	74/-
Northants foundry No. 3	—
Dalzell, No. 3	100/- to 105/-
Summerlee, No. 3	90/- to 95/-
Glengarnock, No. 3	90/- to 95/-
Gartsherrie, No. 3	90/- to 95/-
Monkland, No. 3	90/- to 95/-
Coltness, No. 3	90/- to 95/-
Shotts, No. 3	90/- to 95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 15 0 to	10 15 0
Angles	—	
Tees to 3 united ins.	—	
Nut and bolt iron	9 0 0	
Hoops	14 10 0	
Marked bars (Staffs.) f.o.t.	13 0 0	
Gas strip	12 10 0	
Bolts and nuts, ¾ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 2 6	
Boiler plts.	10 10 0	
Chequer plts.	10 5 0	
Angles	7 12 6	
Tees	8 12 6	
Joists	7 12 6	
Rounds and squares, 3 in. to 5½ in.	7 15 0	
Rounds under 3 in. to ⅜ in. (Untested)	8 0 0 and upwards	
Flats, over 5 in. wide and up	9 2 6	
Flats, 5 in. to 1½ in.	8 2 6	
Rails, heavy	8 2 6 to	8 7 6
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	10 7 6	
Galv. cor. shts., 24g.	13 15 0	
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	£5 15 0 to	6 10 0
Billets, hard	8 2 6	
Sheet bars	£5 12 6 to	5 15 0
Tin bars	£5 12 6 to	5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 2¾
Wire	1 3¼
Rods	1 2¾
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	19.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	2.90
Sheets, galv., No. 24	3.75
Sheets, blue an'l'd., 9 and 10	2.15
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	17/7½
,,	28×20	,,	35/3
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/-
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered, £18 10 0 to	19 0 0
Rolled Ord. £15 0 0 to	£15 10 0
Nail rods £15 7 6 to	£15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron £5 15 0 to	£6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½% ..	.. 45%
Water	63½% ..	.. 40%
Steam	60% ..	.. 35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Oct. 27 ..	56 7 6	inc.	9d.
,, 28 ..	56 7 6	No change	
,, 31 ..	56 11 3	inc.	3/9
Nov. 1 ..	57 0 0	,,	8/9
,, 2 ..	57 17 6	,,	17/6

Electrolytic Copper.

	£ s. d.		
Oct. 27 ..	62 12 6	No change	
,, 28 ..	62 12 6	,, ,,	
,, 31 ..	62 12 6	,, ,,	
Nov. 1 ..	62 12 6	,, ,,	
,, 2 ..	62 17 6	inc.	5/–

Standard Tin (cash).

	£ s. d.		
Oct. 27 ..	264 15 0	dec.	40/–
,, 28 ..	262 7 6	,,	47/6
,, 31 ..	261 10 0	,,	17/6
Nov. 1 ..	259 12 6	,,	37/6
,, 2 ..	258 5 0	,,	27/6

Tin (English ingots).

	£ s. d.		
Oct. 27 ..	264 5 0	dec.	35/–
,, 28 ..	262 0 0	,,	45/–
,, 31 ..	261 0 0	,,	20/–
Nov. 1 ..	259 5 0	,,	35/–
,, 2 ..	257 10 0	,,	35/–

Zinc Sheets (English).

	£ s. d.		
Oct. 27 ..	36 0 0	No change	
,, 28 ..	36 0 0	,, ,,	
,, 31 ..	36 0 0	,, ,,	
Nov. 1 ..	36 0 0	,, ,,	
,, 2 ..	36 0 0	,, ,,	

Spelter (ordinary).

	£ s. d.		
Oct. 27 ..	26 11 3	dec.	3/9
,, 28 ..	26 15 0	inc.	3/9
,, 31 ..	26 12 6	dec.	2/6
Nov. 1 ..	26 10 0	,,	2/6
,, 2 ..	26 10 0	No change	

Lead (English).

	£ s. d.		
Oct. 27 ..	21 15 0	No change	
,, 28 ..	22 0 0	inc.	5/–
,, 31 ..	22 0 0	No change	
Nov. 1 ..	22 0 0	,, ,,	
,, 2 ..	22 0 0	,, ,,	

AVERAGE MONTHLY PRICES PER UNIT OF MANGANESE ORE.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1914	10	9½	9½	9½	9.55	9½	9½	*	*	11.9	11.5	11.5	11.07
1915	1 0.3	1 2.63	1 4	1 4	1 8	1 9.88	1 10½	1 8.63	1 8	1 8	1 10.15	2 3.8	1 8.31
1916	2 7½	2 8	2 8	2 7½	2 6	2 6	2 6	2 6	2 7.6	2 8	*	*	2 7.08
1917 ..													
1918 ..			Prices prohibited.										
1919 ..					2 1½	*	2 2½	2 2.3	2 3.13	2 4.4	2 6½	2 7½	2 4.08
1920	2 11.8	3 6½	3 11½	4 1.8	4 5½	4 5½	4 3	4 1.13	4 0	3 9½	3 7½	2 10.7	3 10.19
1921	2 3.63	2 0½	1 8½	1 5.1	1 4½	1 2½	1 2½	1 2.13	1 1.7	1 2½	1 1.94	1 2.06	1 5.15
1922	1 1.63	1 1.44	1 1.1	1 1	1 1.25	1 1.7	1 2.31	1 2.13	1 2.1	1 2.13	1 2.63	1 2.95	1 1.86
1923	1 3.63	1 6.38	1 9.3	1 9½	1 10	1 10	1 9½	1 9	1 0	1 0.13	1 0	1 9½	1 7.89
1924	1 10.88	1 11.2	1 11	1 11½	2 0	1 11½	1 11⅝	1 11	1 10½	1 10½	1 10	1 9½	1 10.94
1925	1 10	1 10	1 10½	1 11	1 11	1 10½	1 9½	1 8½	1 8½	1 7½	1 8½	1 8½	1 9½
1926	1 8½	1 7½	1 8	1 7½	1 5½	1 5½	1 4½	1 4½	1 4½	1 4½	1 7½	1 8½	1 6½
1927	1 8	1 7½	1 7	1 7	1 6½	1 5	1 4½	1 4½	1 4	1 4	—	—	—

* Not quoted.

AVERAGE MONTHLY PRICES OF FERRO-MANGANESE (80 PER CENT.)

Year	Jan.	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1914	9 12 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	11 0 0	12 5 0	11 6 3	10 7 6	10 7 6	9 10 8½
1915	11 0 6	12 10 0	14 10 0	15 0 0	17 15 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	17 11 3½
1916	20 0 0	22 10 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	52 0 0	25 0 0	25 0 0	25 0 0	23 10 10
1917	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0
1918	25 0 0	26 10 0	25 0 0	*	*	*	*	*	*	*	*	*	25 10 0
1919	*	*	*		25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	24 10 0	23 0 0	25 10 0	24 14 3
1920	27 18 0	30 0 0	31 17 6	35 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	36 10 0	33 16 0	34 15 1½
1921	31 0 0	27 5 0	23 12 6	21 18 0	21 0 0	18 0 0	18 0 0	18 0 0	17 2 0	16 0 0	15 6 0	15 0 0	20 3 1½
1922	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0
1923	15 0 0	15 0 0	16 0 0	17 5 0	18 0 0	18 0 0	18 0 0	18 0 0	18 0 0	17 15 0	17 0 0	17 0 0	17 1 8
1924	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	16 10 0	14 10 0	13 10 0	13 10 0	14 3 4	14 15 0	15 14 10½
1925	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1926	15 10 0	15 10 0	15 9 0	15 0 0	15 0 0	15 0 0	15 0 0	14 5 0	14 0 0	14 10 0	15 5 0	16 0 0	15 0 9
1927	16 0 0	16 0 0	16 0 0	15 0 0	13 10 0	12 0 0	12 0 0	12 0 0	12 6 0	13 0 0	—	—	—

* Not quoted.

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18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET. LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
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PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

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ZETLAND ROAD MIDDLESBROUGH.

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(A remittance should accompany instructions.)

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FOUNDRY MANAGER OR FOREMAN.—Wanted, a position in Heavy and Light Engineering or General Jobbing; loam, dry sand, green sand, plate and machine moulding; 20 years' experience; highest references; mixing of metals; member of I.B.F.—Box 438, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER, twenty years' experience, desires post; thoroughly conversant with up-to-date Foundry practice; good references; would consider post as Representative of first-class foundry requisite and equipment manufacturers.—Please state terms and territory. Box 466, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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BUSINESS MAN of standing and with many years' Foundry and Allied Trades' experience, disposes of spare time and would accept one or two Directorships where his experience, especially in Sales Promotion, would be of value; no objection to character of business, but must be a firm of repute; no immediate investment.—Applications, in absolute confidence, to Box 482, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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MERCHANT FIRM, having well-appointed Offices in Westminster, with qualified Secretarial and Technical Staff and Overseas Shipping connection, is prepared to act as London and/or Export Agents for a manufacturing firm.—Write, "T. J.," c/o J. W. Vickers & Company, Limited, 24, Austin Friars, E.C.2.

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RAILWAY SIDINGS to L.M.S. and L.N.E. Rlys. Area about 11 acres, FREEHOLD. Works well situated and compact. Floor space about 145,000 sq. ft.

Full particulars and terms furnished on application.

THOS. W. WARD, LTD.,
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MACHINERY PLANT, &c., FOR SALE.

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150-Ton VERTICAL HYDRAULIC FORGING PRESS; working pressure, 1,500 lbs.; ram, 19 in. diam.; stroke, 2 ft.

250-Tons POWERFUL HYDRAULIC PRESS, with 22-in. ram; working pressure, 1,500 lbs.; max. daylight, 5 ft.; min., 2 ft.

HYDRAULIC INTENSIFIER; large ram 8½ in. diam., small ram 2½ in.; daylight, 20 in.; large ram 1,500 lbs., small ram 9 tons per sq. in.

Eight-ton STEAM DERRICK CRANE (Anderson); 55 ft. steel latticed jib; steel mast; vertical boiler, 7 ft. x 3 ft. 6 in., for 80 lbs. working pressure.

Three-ton STEAM DERRICK CRANE (Morgan); 59-ft. timber jib; steel mast; vertical boiler, 6 ft. 6 in. x 3 ft. 6 in., for 80 lbs. working pressure.

VERTICAL COCHRAN LAND-TYPE BOILER, for gas firing, 16 ft. 3 in. high x 7 ft. 6 in. diam.; working pressure, 80 lbs. per square inch.

LOCO.-TYPE BOILER, 10 N.H.P.; reinsure 150 lbs. pressure.

20-H.P. Portable Engine and Boiler, by Rustons'; reinsure 100 lbs. pressure.

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One 30-cwt. Cupola, by Constructional Engineering Company, overall height 31 ft., dia. of shell outside 2 ft. 6 in.

Two Moulding Machines, by Tabor.

One ditto, Mumford.

One-ton geared Ladle.

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MACHINERY.—*Continued.*

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PARTING POWDER.—Have you tried ours? Efficient and cheap.—Wm. Olsen, Ltd., Cogan Street, Hull.

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TABOR 30×20 Plain Shockless Bumper ..	£20
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MUMFORD 18×12 Power Squeezer ..	£45
MUMFORD 36×24 Plain Bumper	£28
TWO FARWELL Squeezers, complete ea.	£12
FOUR Darling & Sellars 32×20 Turnover ..	£12
ONE OSBORN Portable Plain Squeezer ..	£18

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

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ALEX. HAMMOND, *Foundry Machinery Merchant.*
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